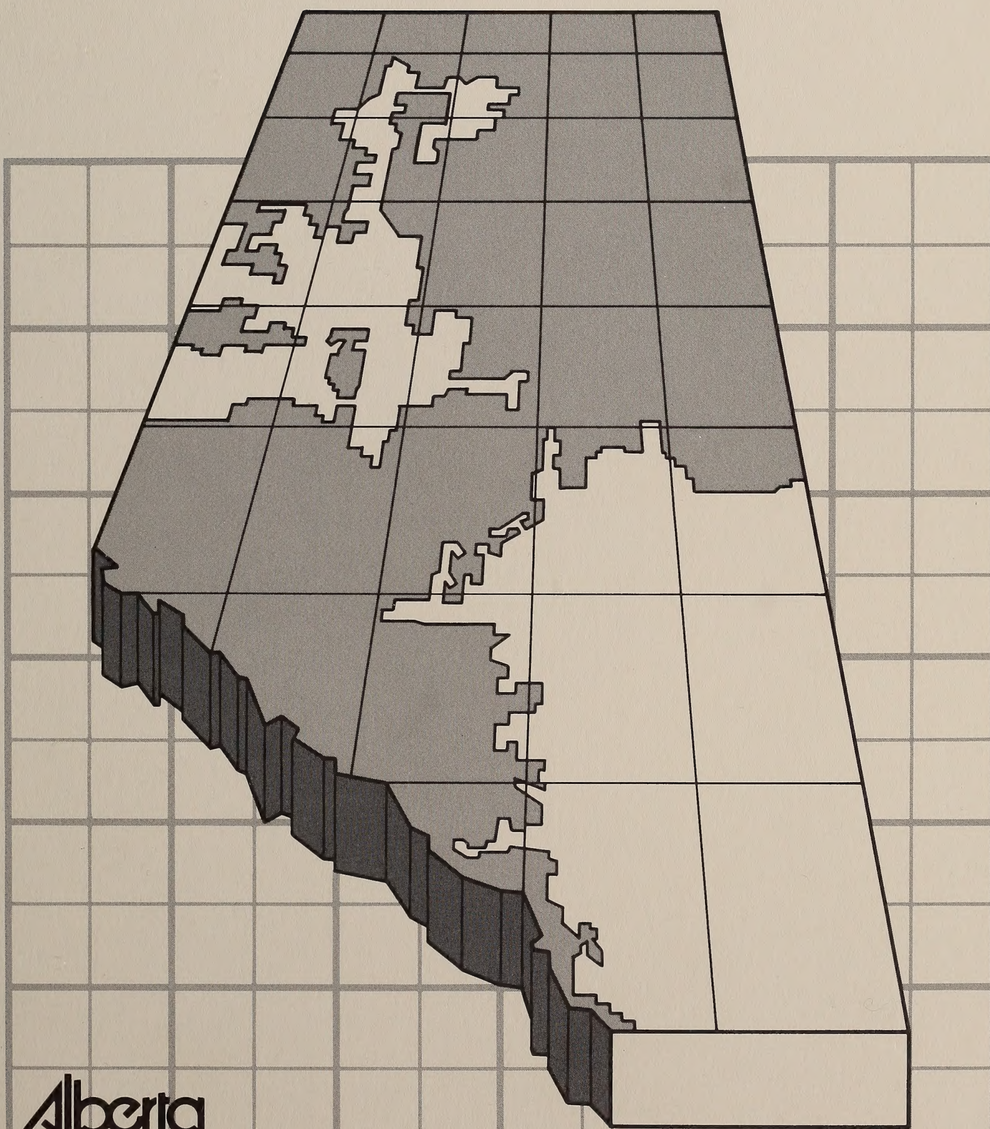
Agricultural Land Base Study

Economic Impact Analysis



Alberta

AGRICULTURAL LAND BASE STUDY:

DEVELOPMENT OPPORTUNITIES FOR THE FUTURE

ECONOMIC IMPACT ANALYSIS

Alberta
Agriculture
Environment
Forestry, Lands and Wildlife
Municipal Affairs
Transportation

Edmonton
January, 1988

FOREWORD

This document forms one of a series of technical background reports to the Agricultural Land Base Study Summary Report. The study was undertaken jointly by the Departments of Agriculture, Forestry, Lands and Wildlife, Environment, Municipal Affairs and Transportation under the guidance of a Steering Committee and its Sub-Committee, comprising representatives of the five departments, listed on page iv. This economic report examined both the direct on-farm and indirect costs and benefits of a number of alternatives for increasing agricultural production. It examined the economic efficiency of each alternative as well as the impact on the growth of the economy.

A study of this magnitude required the involvement of many individuals and agencies. We particularly wish to recognize the major author of the report Kathleen MacDonald-Date and researchers Peter Woloshyn and Ron Desjardins. The study was done with substantial consultation with the departments involved through an Economics Working Group, chaired by Alf Birch. Contributors to specific areas of the report were Mark Anielski who provided the forestry data and analysis and Doug Younie who provided the off-farm irrigation costs and flood control data. Infrastructure costs for the Green area were provided by various departments and agencies. Bruce Wyley, Graham Power, Bob Shorten and Ron Miller were among the contributors of these data.

There was valuable consultation on methodology with Professors William Phillips and Wayne Anderson, University of Alberta. Technical input was provided by a number of specialists in the departments. Research assistance was provided by Dianne Hope and Julie Egglestone. The drainage analysis was based on data from the Inventory of Alberta's Drainage Requirements by Marv Anderson & Associates and Len Leskiw of Pedology Consultants. The wildlife analysis was based on work done by W. Adamowicz, J. Asafu-Adjaye, W. Phillips, K. Bodden and R. Weatherill for the Land Base Study. Typing of the numerous drafts was done by Shelley Cole and June Gingras, Alberta Agriculture, editing by Marilyn

Brown, Alberta Energy/Forestry, Lands and Wildlife and graphics and computer assistance by Ken Hemmerling, Alberta Agriculture. The maps appended to the report were produced by the Resource Evaluation and Planning Division, Alberta Energy and Natural Resources.

While appreciation is expressed for the input of all of these individuals who often operated under very tight time constraints, the responsibility for the report and the results rests solely with the Production & Resource Economics Branch.

Carlyle Ross
Branch Head
Production & Resource Economics

LIST OF COMMITTEES

The members of the various committees responsible for the Agricultural Land Base Study are listed below.

ALBS Steering Committee

A.O. Olson, Research and Resource Development Sector, Alberta Agriculture (Chairman)

L.J Cooke, Resource Evaluation and Planning Division, Alberta Forestry, Lands and Wildlife

P.G. Melnychuk, Water Resources Management Services, Alberta Environment

R.J.C. Ford, Improvement Districts Operations Division, Alberta Municipal Affairs

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EXECUTIVE SUMMARY

The Agricultural Land Base Study (ALBS) was an interdepartmental study designed to examine eleven identified alternatives for agricultural resource development and to evaluate these on the basis of both physical and economic potential.[1]

The alternatives were[2]:

1. Green Area Conversion;
2. Irrigation Expansion;
3. Drainage;
4. Deep Plowing;
5. Liming;
6. Summerfallow Reduction;
7. Range Improvement;
8. Prairie Range Conversion;
9. Woodland Conversion; and
10. Saline Soil Reclamation:
    a) Dryland,
    b) Irrigated.

This study, the final phase of the economic component, examines the direct and indirect costs and benefits of each alternative. It brings together results from a number of studies and does further analysis to the data drawn from the various sources. It examines direct (on-farm) benefits and costs, public and private investment, benefits foregone and secondary benefits.

The purpose of the study was to examine the economic efficiency or productivity of each alternative from the perspective of society, over a long term, and to evaluate the economic impact of each alternative on the

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1. Departments involved are: Agriculture, Forestry, Lands and Wildlife, Environment, Municipal Affairs and Transportation.

2. Flood control was also identified but a complete analysis was not undertaken because of the small acreage affected and insufficient economic data. A brief description of the problem is however provided in this report.

provincial economy. These two measures were derived through direct net benefit analysis and multiplier analysis. Discount analysis formed an integral part of the study and both analyses were based on economic costs and benefits. Thus, transfer payments were not included since these simply redistribute money within the economy and do not make society as a whole better or worse off. The alternatives examined were sub-divided into major infrastructure alternatives (Green Area conversion, irrigation expansion and drainage); and direct development alternatives (all others).

The direct net benefit to society represented the net return to land, labor, management and existing investment. It was derived as the difference between gross output and the sum of on-farm variable and investment costs, public investment costs and net benefits foregone. Where the value was positive all investment costs (private and public) as well as opportunity costs identified (benefits foregone) were covered by the benefits gained. The surplus was the return to labor and existing assets. Where the value was negative, not all costs were covered and there was no return to land, labor and existing assets. Benefit-cost ratios were also derived for each alternative.

The impact on the provincial economy was measured through multiplier analysis. The change in gross domestic product (GDP) at factor cost was derived as the change in direct value-added plus the change in indirect value-added. The direct value-added to agriculture represented the return to primary inputs (including the capital investment). Thus, it is a measure of growth and not productivity or efficiency. This value was expressed as a ratio to total investment (private and public). The ratio represented the increase in agriculture GDP per dollar of investment. Similarly, the ratio of the total benefit (total direct plus indirect value-added) to the total investment represented the increase in total provincial GDP per dollar of investment. It must be noted that GDP contains components of costs and thus these ratios are not true benefit-cost ratios and are not measures of efficiency.

Finally, these macro values expressed in terms of millions of acres developed over 50 or 100 years, were compared with the farmer's expected

returns from a single investment on a small scale and over a shorter term. The latter values were taken from the on-farm financial analysis and indicated the net return to the farmer. Calculation of this value included transfer payments between the farmer and society (taxes, subsidies, interest payments etc.), since these payments affect the financial position of the farmer.

A summary of results is provided in the following tables. Summary Table I presents global results for the entire acreage associated with each alternative. The second table gives results on a per acre basis (Summary Table II).

1. The total acreage figures were taken from the "ALBS Agricultural Inventory" and the "Inventory of Alberta's Drainage Requirement" reports with some modifications to reflect results of the "ALBS Economic and Financial Analysis: Direct Benefits and Costs". The sub-options with negative economic returns at the farm level were excluded from this analysis. They were summerfallow reduction on the Brown soil zone and woodland range improvement on all soil zones. No analysis was provided for reclamation of dryland saline soils on the Black and Gray soil zones, since the required information for analysis was not available.

2. Total investment included both the private on-farm investment in development or improvement and the public investment costs in roads, irrigation and drainage infrastructure. Only the three major infrastructure alternatives contained public investment.

3. The net direct benefit to society (NPV from agriculture) was derived by deducting all costs and net benefits foregone from gross revenue. This value ranged from a high of $1,788 million for (7 million acres of) woodland conversion to a negative $1,150 for (1.1 million acres of) irrigation expansion. The highest NPV per acre was associated with irrigated saline reclamation at $400 per acre. The next highest was woodland conversion at $253 per acre. Of the three major infrastructure alternatives, only drainage showed a positive NPV.

SUMMARY TABLE I

SUMMARY OF RESULTS - BASED ON TOTAL ACREAGES

Alternative	Acreage[1] ('000 acres)	Total[2] Investment	Net[3] Direct Benefit	Direct[4] Value-Added	Total[5] Value-Added
		--- (present value, million $)[6]	------		
	(1)	(2)	(3)	(4)	(5)
Major Infrastructure Alternatives					
Green Area Conversion	9,200	1,520	-816	1,758	-1,941
Irrigation Expansion	1,139	1,783	-1,150	639	1,934
Drainage	2,119	702	23	739	1,366
Direct Development Alternatives					
Deep Plowing	2,220	146	422	568	695
Liming Acid Soils	2,510	95	124	219	294
Fallow Reduction	930	0	48	48	64
Range Improvement	1,040	40	-1	81	42
Range Conversion	3,530	85	268	392	511
Woodland Conversion	7,070	553	1,788	2,406	3,417
Saline Reclamation - Dryland	1,310	27	44	71	118
- Irrigated	250	47	100	147	225

1. Acreage excludes summerfallow reduction on Brown soils, woodland range improvement on all soils and dryland saline reclamation on Black and Gray soils.

2. On-farm plus public investment (includes public expenditure of $531 million for expansion, $1,647 million for irrigation and $374 million for drainage).

3. Gross agriculture output less all costs (variable and investment) and benefits foregone from forestry, hunting and trapping.

4. Value-added in agriculture (gross values less variable costs).

5. Direct and secondary value-added in agriculture and public and private investment, less direct and secondary value-added in forestry, hunting and trapping.

6. All present values based on infinite stream of benefits and costs.

SUMMARY TABLE II

SUMMARY OF RESULTS - ON A PER ACRE BASIS

Alternative	Total[1] Investment	Net[2] Direct Benefit	Direct[3] Value-Added	Total[4] Value-Added	-- Ratio of[5] -- Direct Value-Added/ Total Investment	Total Value-Added/ Total Investment	Av. Annual[7] Cash Flow To Producer
	---- (present value/$/acre)[6]----						($/ac)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Major Infrastructure Alternatives							
Green Area Conversion	165	-89	191	-211	1.16	-1.28	-18
Irrigation Exp.	1,565	-1,009	561	1,698	0.36	1.08	23 to 130
Drainage	331	11	349	645	1.05	1.95	17 to 52
Direct Development Alternatives							
Deep Plowing	66	190	256	313	3.89	4.76	17 to 46
Liming Acid Soils	38	49	87	117	2.31	3.09	10 to 11
Fallow Reduction[8]	0	52	52	69	*	*	4 to 12
Range Improvement	38	-1	78	40	2.03	1.05	1 to 21
Range Conversion	24	77	111	144	6.11	6.01	28 to 41
Woodland Conversion	75	253	340	483	4.35	6.17	26 to 57
Saline Reclamation - Dryland	21	34	54	90	2.63	4.37	19
- Irrigated	188	400	588	900	3.13	4.79	52

1. On-farm plus public investment.

2. Gross agriculture output less all costs (variable and investment) and benefits foregone from forestry, hunting and trapping.

3. Value-added in agriculture (gross values less variable costs).

4. Direct and secondary value-added in agriculture and public and private investment, less direct and secondary value-added in forestry, hunting and trapping.

5. Indicators of direct and total value-added per dollar of total investment, respectively (not B/C ratios as derived in "Direct Benefits and Costs Analysis").

6. All present values based on infinite stream of benefits and costs.

7. Based on financial NPV (returns to land, labor, management and existing investment). Taken from "ALBS Economic and Financial Analysis: Direct Benefits and Costs".

8. No investment costs, therefore the ratio of value-added to investment approaches an infinite value.

4. The direct value-added to agriculture (expressed as a present value) was derived by deducting only operating costs from gross revenue. This value ranged from a high of $2,406 million for woodland conversion to a low of $48 million for fallow reduction. The highest per acre values were $588 per acre for irrigated saline reclamation and $561 per acre for irrigation expansion. When forestry and wildlife value-added benefits foregone were deducted, values for some alternatives fell (not shown in tables). For example, the range improvement value fell from $81 to $39 million.

5. Total value-added to the economy represents the direct plus the indirect or secondary value-added expressed as a present value. This value ranged from $3,417 million for woodland conversion to $42 million for range improvement. Green Area conversion had a negative value of $1,941 million. Irrigation expansion had the highest per acre value of $1,698 and irrigated saline reclamation the next highest at $900 per acre. Drainage was next at $645 per acre. These values took into account the value-added benefit foregone from forestry and wildlife as well as the value-added benefit gained from capital investment on-farm and off-farm.

6. The ratios of direct value-added to total investment indicated that the direct development alternatives increased the value-added (GDP) of agriculture by two to six dollars for each dollar of investment. The Green Area conversion and drainage alternatives produced marginal increases of $1.16 and $1.05 per dollar of investment respectively. The irrigation alternative was lower at 36 cents per dollar of investment (irrigation having a high public investment cost). Deducting forestry and wildlife value-added benefits foregone had the impact of reducing the ratios. For example Green Area conversion fell to a negative value and irrigation to 35 cents per dollar of investment (not shown in tables).

7. Most ratios for total value-added (total GDP increase) to total investment were higher than the previous ratios (based on direct agriculture GDP) since they included direct and indirect value-added.

The exceptions were Green Area conversion and prairie range improvement. With Green Area conversion there was a net reduction in GDP resulting from the forestry benefits foregone. With range conversion the ratio fell from 2.03 to 1.05. Other values ranged from between one dollar (irrigation expansion) to six dollars (range conversion and woodland conversion) per dollar of investment. These ratios took into account the value-added benefit foregone for forestry and wildlife.

8. The average annual cash flow represents the farmer's expected return taking into account all on-farm financial costs and returns, including transfer payments. These ranged from a high of $130 per acre for irrigation (Zone A1) to a negative $18 per acre for Green Area conversion. These results were taken directly from the "ALBS Economic and Financial Analysis: Direct Benefits and Costs" (with the same exclusions noted in 1.).

The results summarized in the previous table were ranked in order of magnitude on the basis of dollars per acre or dollars per dollar of investment. These are shown in Summary Table III. The results are from three perspectives: (i) farmer's annual income; (ii) economic efficiency (net direct benefit); and (iii) growth. Very few alternatives had high ratings for each economic measure. The exceptions were woodland conversion, reclamation of irrigated saline soils and deep plowing solonetzic soils. The first two ranked between first and fifth for each economic measure. Deep plowing was also fairly consistent, being ranked between third and fifth by each measure.

On the other hand, alternatives with high public investment were ranked moderate to high for agricultural growth (Green Area conversion in sixth position, irrigation in second position and drainage in third position) but low for economic efficiency and/or growth per dollar invested. Irrigation and drainage also ranked among the highest for the farmer's cash flow.

SUMMARY TABLE III

RANKING BY DIFFERENT CRITERIA[1]

Alternative	Farmer's Cash Flow	Net Direct Benefit	Agricul. Sector Growth	Prov. Economy Growth	Ag.Growth per $ Invested	Prov.Growth per $ Invested
	(1)	(2)	(3)	(4)	(5)	(6)
Major Infrastructure Alternatives						
Green Area Conversion	11	10	6	11	9	11
Irrigation Expansion	1	11	2	1	11	9
Drainage	3	8	3	3	10	8
Direct Development Alternatives						
Deep Plowing	5	3	5	5	4	5
Liming	10	6	8	7	7	7
Fallow Reduction[2]	9	5	11	9	1	1
Range Improvement	8	9	9	10	8	10
Range Conversion	6	4	7	6	2	3
Woodland Conversion	2	2	4	4	3	2
Saline Reclamation - Dryland	7	7	10	8	6	6
- Irrigated[3]	4	1	1	2	5	4

1. Columns (1) to (4) based on per acre values and columns (5) and (6) are ratios. (Derived from the previous tables).

2. Growth per dollar of investment approaches an infinite value for fallow reduction since there was no investment cost.

3. No off-farm infrastructure cost measured. Inclusion of such project costs would affect the ranking under columns (2), (5) and (6).

The results presented in this manner should allow the reader to weigh the benefits in terms of farmer's income or economic efficiency against the benefits of growth. The ranking or rating chosen as input into any decision-making process will be dependent upon the goals of the program. If the major goal is efficiency or productivity, alternatives with a high ranking for economic efficiency and growth per dollar invested would be appropriate. If farmer financial enhancement is the goal then alternatives with high farmer cash flows would be appropriate. Finally, if growth is the major goal, those alternatives with high ratings for agricultural growth and provincial economic growth would be applicable.

In conclusion, it must be noted that the analysis in this report included measurable economic impacts and infrastructure costs. A number of other impacts which were discussed briefly, were not quantified and therefore not included in the economic analysis. These included environmental and conservation issues (both negative and positive) certain municipal impacts, and impacts on non-consumptive use of wildlife and on fishing. Also, in most alternatives, except if specifically related to livestock, the benefits were measured in terms of crop production. The analysis did not include a measure of value-added for livestock production.

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1. INTRODUCTION

1.1 BACKGROUND

The economic benefits and costs of each of the alternatives examined in the Agricultural Land Base Study were derived from estimates prepared by the various departments involved in the study.[1] The alternatives identified for investigation were:

Green Area Conversion;
Irrigation Expansion;
Drainage;
Deep Plowing Solonetzic Soils;
Liming Acid Soils;
Summerfallow Reduction;
Flood Control;
Range Improvement;
Range Conversion;
Woodland Conversion; and
Reclamation of Salinized Land:
a] Dryland, and
b] Irrigated.

Area estimates for each alternative were taken from "ALBS Agricultural Inventory" and direct on-farm benefits and costs derived from "ALBS Economic and Financial Analysis: Direct Benefits & Costs". Off-farm infrastructure costs for Green Area conversion were determined through consultation with the relevant departments and agencies. Irrigation infrastructure costs were compiled by Alberta Environment from the "South Saskatchewan River Basin Scenario Report". Drainage costs were derived from the "Inventory of Alberta's Drainage Requirements" reports.

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1. Departments of Agriculture, Forestry, Lands and Wildlife, Environment, Municipal Affairs and Transportation.

Estimates of benefits foregone from timber production were taken from the "ALBS Alberta Forest Service Socio-Economic Analysis" and those for hunting and trapping from the "ALBS Wildlife Analysis, Economic Component". No attempt was made to measure other benefits foregone such as the potential for increased erosion, the impacts on water quality and the non-consumptive use of wildlife. These impacts are, nevertheless, important in terms of a complete and accurate picture of the consequences of resource development. The "ALBS: Analysis of Impacts on Other Resources" report describes many of these effects and should be read in conjunction with this report. That report also presents the qualitative information on which the economic analysis of foregone benefits or opportunity costs for both the forestry and wildlife sectors was based. Secondary benefits gained or foregone were estimated from the direct benefits through multiplier analysis.

1.2 OBJECTIVES

Terms of reference for the Agricultural Land Base Study state that the objectives of the study include investigation of the effect of agricultural resource development alternatives on other land and water users and the expression of relative benefits and costs of such management changes in economic terms. This report therefore brings together economic information on four broad topics.

1. Direct benefits and costs. Net returns to the farmer are the major reason for agricultural resource development. While there may be positive effects on other sectors of the economy, these would rarely be sufficient to justify a proposed undertaking.

2. Public and private investment (infrastructure) requirements. A number of the identified development alternatives require considerable public investment in such things as roads, utilities and irrigation and drainage capital works. These are part of the overall social cost of the various alternatives and must be part of the economic accounting in a study such as this. This report does not investigate the various financing or cost sharing approaches

which would be possible, but treats costs on and off the farm as attributable to the farmer and society respectively.

3. Benefits foregone. To the extent that natural resources are currently used by non-agricultural sectors such as forestry or wildlife production, agricultural development can reduce the net benefits to those sectors and create opportunity costs which must be taken into account in an economic impact analysis. An attempt has been made to quantify, in the "ALBS: Analysis of Impacts on Other Resources" report, and economically evaluate, in this report, as many of these impacts as possible.

4. Secondary benefits. Agricultural resource development projects may create spin-off benefits throughout the provincial economy as a result of increased purchase of farm inputs, increased public investment (such as the construction of roads or irrigation canals), increased processing and handling of farm products, and the increased spending of provincial household incomes. Secondary benefits produced by existing resource uses would be lost as a result of the agricultural development. This category must be viewed with caution since resources may have been employed elsewhere and therefore a project may not create any new income but simply redistribute existing income and activity.

While each of the identified development alternatives has associated direct and secondary benefits and costs, they do not all have public investment requirements or identified benefits foregone in other resource sectors. Table 1.1 shows the alternatives for which identified public investment costs and benefits foregone were measured in this report. For those cases where a cost is not identified, either no effect or cost is expected or there is not enough information available to estimate it. Many of the latter cases are dealt with qualitatively in the "Analysis of Impacts on Other Resources" report.

TABLE 1.1

PUBLIC INVESTMENT REQUIREMENTS AND BENEFITS FOREGONE - IDENTIFIED ECONOMIC IMPACTS

Alternative	Public Investment Requirement	Benefits Foregone
Green Area Conversion	X	Forestry Wildlife Agriculture (Forest Grazing)
Irrigation Expansion[1]	X	Wildlife
Drainage	X	Wildlife
Deep Plowing Solonetzic Soils		
Liming Acid Soils		
Summerfallow Reduction		
Flood Control	X	
Range Improvement[1]		Wildlife
Range Conversion[1]		Wildlife
Woodland Conversion[1]		Wildlife
Reclamation of Saline Land		

1. Foregone agricultural benefits were treated as costs in the on-farm analysis.

The societal analysis was carried out at two separate and distinct levels which are not strictly cumulative or additive.

1. The direct benefits and costs analysis examined all net direct benefits, all total public expenditure and all net benefits foregone. This provided a direct net benefit expressed in present value terms.

Example:

			Ag.
Direct Net Benefit		Gross Revenue	$ 195
	-	Operating Costs	- 92
		Gross Margin (Value-Added)	103
	-	Investment Cost	- 55
	Direct Net Benefit (On-farm)		48
	-	Public Investment	10
	-	Net Benefit Foregone	3
	Direct Net Benefit (To Society)		35

2. The multiplier analysis examined the direct value-added (gross margins) from output and investment less the direct value-added of output losses plus the net indirect or secondary benefits. The sum of the direct value-added and the secondary benefits (net of losses) provided the total benefits estimate.

Example:

			Ag.	Invest.	Total
Total Benefit		Gross Revenue X Multiplier	$ 139	39	178
	-	Gross Ben. Foregone X Mult.	5	-	5
	Total Benefit		134	39	173
Direct Value-Added		Gross Value - Operating Costs	103	35	138
	-	Value-Added Foregone	4	-	4
	Direct Value-Added		99	35	134
Secondary Benefit		Total Benefit - Value-Added	36	4	40
	-	Secondary Benefit Foregone	1	-	1
	Secondary Benefit		35	4	39

The two levels of analysis are both based on gross revenues and/or gross expenditure values. However, the methods of analysis are quite distinct, using different analytical tools and producing results from different perspectives. The "direct net" on-farm benefit of $48 was derived by deducting both operating and investment costs from the gross value of agricultural output. The "direct net" benefit to society was calculated by further deducting public costs and the benefits foregone, from the on-farm value. These two values are measures of economic efficiency at the farm and provincial levels respectively and are net returns after covering the investment costs. They give some indication of change in productivity, not growth.

In contrast, the "total benefit" of $173, derived through multiplier analysis, was composed of a "direct value-added" component of $134 plus a "secondary benefit" or "indirect value-added" component of $39. These values are measures of the returns to primary inputs (indirect taxes, wages and salaries, net income and surplus). They do not take economic efficiency into account and are returns before covering the investment costs. They do give some indication of the impact on Gross Domestic Product and thus on growth, rather than productivity.

In the multiplier analysis only operating costs were deducted to derive the "direct" agricultural value-added. Value-added was also determined for the investment component. Together these made up a "direct value-added" of $138. For the benefits foregone the value-added was $4. Secondary benefits were derived for both the agricultural output and the investment component. Together these made up $40. Secondary benefits foregone were worth $1. Thus, the total benefits derived through multiplier analysis were $173 (composed of $134 direct value-added and $39 secondary).

The direct net on-farm benefits ($48) and the secondary benefits ($39) should not be added together. The direct value-added ($134) and secondary benefits ($39) together make up the total benefit (or value-added). The "direct net benefits" form only part of the "direct value-added benefits".

1.3 DIRECT NET BENEFITS

To derive the direct net benefits for each of the alternatives, estimates were determined for operating costs and returns from the agricultural activity, on-farm investment, off-farm costs (where applicable) and net benefits foregone from other uses. The methods of estimation and discounting to present values were described in the "ALBS: Economic and Financial Analysis: Direct Benefits and Costs" report. All benefit and cost streams were discounted at a 5 per cent rate.

The original on-farm economic and financial analyses were based on specific project lives. These were different for each alternative and were applicable to individual farms and did not take into account the scale of the total area estimate for each alternative. It was therefore necessary to adjust the data for large acreages to make the alternatives more comparable. This was done by the use of phasing-in and assuming repeated investments, where appropriate, to achieve sustained or continuous benefits. Phasing-in for the Green Area conversion, irrigation and drainage alternatives was based on development over 100 years. For the other alternatives a 50 year phasing-in period was used to reflect in part physical capacity and other restricting factors. These adjustments were also made to the estimates of forestry and wildlife benefits foregone. Total area estimates and phasing-in periods are given in Table 1.2.

For each alternative the benefits gained or lost were derived for an infinite period, and expressed on a per acre basis. The per acre estimates were then grossed up to the total area estimates, taking into account the phasing-in rate that was assumed. For example, for liming it was assumed that the total acreage would be phased in over 50 years and that each acre limed would be relimed every 15 years, to achieve sustained benefits. Thus, the NPV for each acre was based on an investment in liming every 15 year period and the subsequent benefits from each investment over each 15 year period. This value was then multiplied by one-fiftieth of the acreage and the annuity factor for 50 years, to derive the total NPV for the entire acreage.

TABLE 1.2

TOTAL AREA ESTIMATES AND PHASING-IN RATES FOR EACH ALTERNATIVE

Alternative	Total Area ('000 acre)	------ Phasing-In ------ (years)	(acres/year)
Major Infrastructure Alternatives			
Green Area Conversion	9,200	100	92,000
Irrigation Expansion[1]	1,139	100	11,390
Drainage[2]	2,119	100	21,190
Direct Development Alternatives			
Deep Plowing Solonetzic Soils	2,220	50	44,400
Liming Acid Soils	2,510	50	50,200
Summerfallow Reduction	930	50	18,600
Flood Control[3]	100	--	--
Range Improvement Prairie Range	1,040	50	20,800
Conversion of Rangeland to Cropland	3,530	50	70,600
Woodland Conversion	7,070	50	141,400
Reclamation of Salinized Lands: Dryland	1,310	50	26,200
Irrigated	250	50	5,000

Source: Derived from ALBS Agricultural Inventory Report and the Drainage Inventory Report (Total Area Estimates).

1. Maximum expansion was chosen from the SSRB report for the irrigation option of the ALBS. Infrastructure put in between years 1 and 65; and acreage phased-in at 11,390 acres per year from year 1.

2. The scenario chosen was drainage of temporary wetlands.

3. There was no economic analysis done for the flood control option.

The following is an example of the process used to derive the NPV for the total acreage limed.

Example: Liming Acid Soils

Soil Zone	(a) Total Acres (000's)	(b) Acres/ Year (000's)	(c) Annuity Factor (50 Yrs)	(d) PV Gross ($/Ac)	(e) PV Net Rev ($/Ac)	(f) PV Gross (Total) -(million $)-	(g) PV Net Rev (Total) -(million $)-
Gray (Peace)	1030	20.6	18.26	224	120	84	45
Gray (Central)	310	6.2	18.26	224	120	25	14
Black	940	18.8	18.26	257	154	88	53
Dark Brown	230	4.6	18.26	253	150	21	13

Where (f) = (b) X (c) X (d); and (g) = (b) X (c) X (e).

1.4 MULTIPLIER ANALYSIS

Spin-off or secondary benefits usually result from activities which produce an increase in output.[1] However, not all researchers in this field support the inclusion of secondary benefits in project analysis. It is argued that project choice should be based on the efficiency aspects of projects as shown by valuation of direct benefits and costs. Secondary benefits may be redistributed rather than additional, unless resources are not fully employed. Where resources are underemployed a new project can create expansionary or multiplier effects. Also, at a regional level it may be important to identify the secondary or multiplier impacts of a given project. The inclusion of secondary benefits in this analysis appears to be justified because of the regional nature of most of the alternatives examined and because of

1. When there is a change in one sector of the economy (e.g production increase in an industry or increased demand for a commodity) there is an impact on the rest of the economy.

underemployment of resources. However, private or public investment in any resource based project would have similar expansionary or multiplier effects. Some researchers suggest that alternate uses of capital should be shadow-priced. In this study the capital investment is valued at 100% reflecting no alternate use.

To calculate secondary benefits, multipliers were selected from those published by the Alberta Bureau of Statistics.[1] These were based on a 1974 input-output model of the Alberta economy. In such a model, the economy is divided into three sectors: the processing sector; the payments sector; and the final demand sector. The last sector is the one in which changes occur which are transmitted througout the rest of the economy. It is in this (final demand) sector that transactions originate.

There is no fixed rule for including or excluding any specific economic activity in the final demand or in the payments sector. In an open model households are included in the final demand sector not the processing sector. The reasoning behind this is that household consumption is exogenous to income (income is a function of consumption, government expenditure, exports and capital formation). In the input-output model, changes in the processing sector equate changes in income (or benefits) brought about by changes in the demand sector. Household consumption is thus treated as part of final demand.

For this analysis the multipliers used were the simple multipliers (absolute form, with leakages) by detailed industry. The specific multipliers chosen were those for Gross Domestic Product (G.D.P.) at factor cost. Multipliers used in this analysis are provided in Table 1.3.

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1. Economic Multipliers for Alberta Industries and Commodities, Alberta Bureau of Statistics, Alberta Treasury, March 1984. Table A6, page 50.

TABLE 1.3

MULTIPLIERS BY INDUSTRY OR ACTIVITY

Detailed Industry	Alternative or Activity	Multiplier GDP[1]	1982 GM[2] (%)	1974 GM[3] (%)	Modified[4] Multiplier
ALBS Alternatives		A	B	C	
	Green Area Conversion	0.870	52.88	64.58	0.712
	Irrigation Expansion	0.870	63.01	64.58	0.849
	Drainage	0.870	84.45	64.58	1.120
	Fallow Reduction	0.870	22.91	64.58	0.309
	Range Improvement	0.870	66.05	64.58	0.890
	Range Conversion	0.870	20.70	64.58	0.279
	Woodland Conversion	0.870	48.95	64.58	0.659
	Dryland Salinity	0.870	36.68	64.58	0.494
	Irrigated Salinity	0.870	28.75	64.58	0.387
Construction		0.661	39.98	45.46	0.581
Wholesale/Retail		0.880	68.05	68.63	0.873
Mines & Quarries Mining Services Transp. & Storage	Liming[5]	0.845	55.41	58.44	0.801
Agriculture[6]	Dryland Salinity	0.870	59.62	64.58	0.803
	Forest Grazing	0.870	59.62	64.58	0.803
Wood Industries	Timber Production	0.617	26.75	31.53	0.523
Fish/Hunt/Trap	Trapping	0.945	78.11	87.61	0.843
Wholesale/Retail Food/Accomodation	Hunting[7]	0.839	62.10	62.10	0.839

Sources: Economic Multipliers for Alberta Industries and Commodities, Alberta Bureau of Statistics, Alberta Treasury, March 1984. Table A6, page 50. The Input-Output Structure of the Alberta Economy, 1984. Alberta Bureau of Statistics, Alberta Treasury, March 1984, Table 13. Transactions Matrix for the Alberta Economy, 1979. Statistics Canada Special Computer Printout 1985.

1. Gross domestic product at factor cost.
2. Gross margins for ALBS alternatives and forestry derived from 1982 ALBS data and new computer runs (1985). Others derived from source #3.
3. Value-added derived from source #2.
4. Modified multiplier derived using the following procedure: A X B / C = Modified Multiplier.
5. Average for three industries.
6. On-farm investment in agricultural inputs (salinity), grazing loss from forest cleared (Green Area conversion).
7. Average for two industries.

Simple multipliers are based on an open model which captures inter-industry transactions brought about by a change in final demand.[1] They account for direct impacts (e.g. grain production) and indirect impacts (e.g. fertilizer production and chemical production) but do not account for induced income and expenditure (e.g. purchases made by chemical plant employees).[2] The impact being measured in this study is the industry effect and not the income effect. This is a more conservative approach to estimating the impact. A conservative approach has been adopted because of the many other assumptions underlying the direct on-farm analysis, inventory estimates and the input-output model used in the multiplier analysis. This approach would avoid further compounding of any over estimation in previous studies. This approach is one that represents more closely the direct linkages that occur in the market place. The linkage between wages (wage changes) and the structure of consumer spending is more difficult to justify when looking at marginal changes in income.[3]

Absolute multipliers and not ratio multipliers were used since ratio multipliers require that both cause and impact be expressed in the same terms (e.g. household income). Absolute multipliers measure the impact that a change in an industry's output (e.g. agriculture) would have on the economy (e.g. on G.D.P. or on household income). A portion of any increase in final demand is satisfied through imports, withdrawals from inventory and government production (leakages from domestic production). Therefore, the impact of an increase in final demand on domestic industries is reduced by leakages (mainly imports). Hence, multipliers with leakages were used in this study to account for this effect.

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1. When an industry increases its output, inputs have to be provided by other industries. Increased demands are therefore placed on suppliers of these other industries, and so on through a chain of interdependent industries (the industry effect).

2. Increased production leads to increased staff, more wages and subsequently more consumption (income effect). Direct, indirect and induced impacts are measured by total multipliers based on a closed model (closed to households).

3. Based on discussions with Wayne Anderson, University of Alberta.

Industry multipliers are appropriate since the causal factor in this analysis is a change in production output. Commodity multipliers are used when the causal effect is a change in demand for a commodity. Detailed industry multipliers were chosen since these are based on a larger input-output table and are considered to be more accurate than major industry multipliers. Finally, the multipliers for G.D.P. at factor cost (rather than for gross output) were chosen, to reflect the impact of primary inputs and not intermediate inputs.

Intermediate inputs are the inputs from all other industries supplying commodities to the industry being examined. Primary inputs are those of the industry being studied and consist of indirect taxes (commodity indirect taxes, plus other indirect taxes, less subsidies), wages and salaries, supplementary labor income, net income of unincorporated business and surplus. Net income of unincorporated business includes the accrued net income of farm operators. Surplus includes profits (before taxes and before dividends) and capital consumption allowance. Thus, the value of primary inputs is equivalent to the value-added or to the gross margin of the industry.

In this analysis the gross margins (value-added) of the relevant industries were calculated from: the ALBS, Direct Benefits and Costs data (new gross margin computer runs); Alberta Forest Service data (gross timber production revenues and capital cost estimates); and Fish and Wildlife Division data (hunting and trapping benefits). Phasing in of projects was the same as described for the direct net benefits and costs analysis (Green Area conversion, irrigation and drainage 100 years and all other alternatives 50 years). In calculating the present value (PV) of gross revenues and gross margins for each industry the assumption relating to sustained yield or infinite life was adopted, as applied to the direct net benefit analysis.

For cases requiring a one time investment (such as Green Area conversion) infinite life was built into the PV per acre and reflected revenues and variable costs sustained beyond the original length of the project. For other alternatives the PV per acre was adjusted to reflect the assumption of repeated investments (such as liming). This was achieved by using the gross revenue or gross margin annual equivalent cash flow and converting it to a PV with infinite life.

Multiplier values provided in the ABS publication are based on a simple static input-output model. This assumes capacity exists to meet any increase in demand for goods. For any situation where an increase in demand can only be met by increasing capacity (i.e. resulting in a demand for capital consumption), the actual impact on the economy would be higher than that indicated by the multipliers provided.

An attempt was made to adjust for this underestimation by evaluating the impact of the investments required to bring about the increase in output from the agriculture industry. This was achieved by applying the appropriate multiplier to the investment value for each alternative. For example, a simple average of a group of industries (other mines and quarries, services incidental to mining, and transportation and storage) was applied to the liming investment. This application is valid since the liming activity is not a one time investment but is repeated indefinitely and so constitutes a sustained increase in final demand for output of the corresponding industries.

For the Green Area conversion alternative secondary benefits were derived for clearing and piling, buildings, machinery and equipment and for infrastructure. Some of these are one time investments. However, because of the scale of the conversion and the long phasing in period (100 years), it is appropriate to treat them as a sustained increase in final demand for output of the construction and wholesale and retail industries. The same applies to irrigation infrastructure since this is provided over 65 years and requires long term operating and maintenance activities. Also, the on-farm irrigation sprinkler systems are replaced every 15 years, this combined with the phasing in provides a sustained final demand for wholesale and retail trade industry products. A similar argument applies to the infrastructure required for drainage.

The published multipliers are based on the average production technology and expenditure patterns and prices applicable to 1974. If these variables have changed the relevant multiplier would also change. To adjust for changes which could have occurred since 1974 and also to adjust from a provincial data base to more specific regional and case data, the multiplier values were modified. This was done by

comparing the gross margins (value-added) for agriculture derived in this study for 1982 to the value-added or primary input margins derived from input coefficients published by ABS for 1974.[1]

Example: Rangeland Improvement

PV Gross Output	X	Multiplier (GDP at Factor Cost)	X	Gross Margin Ratio (1982) / Gross Margin Ratio (1974)	=	PV Total Benefit
$123	X	0.87	X	$\frac{0.6605}{0.6458}$	=	$109

In this example, the gross margin or value-added for agriculture was $81, and the secondary benefit $28. The same approach was used to adjust the multipliers for forestry. For industries not investigated in this study (but used for deriving secondary benefits) the adjustment was made by comparing 1974 value-added margins (ABS) with 1979 margins derived from the Statistics Canada input/output model.[2] This was also done for the hunting and trapping activities. The product of the industry output (e.g. gross revenue for agriculture or forestry or investment value for other industries) and the G.D.P. multiplier at factor cost was modified by a ratio of the current (1982 or 1979) gross margin to the 1974 margin.

In some alternatives the increased agricultural output was achieved by a capital investment alone and there was no increase in variable inputs (intermediate inputs). Examples are liming acid soils and deep plowing solonetzic soils. For these alternatives no secondary benefits were derived for the increased agricultural output but the secondary benefits were confined to the investment component.

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1. The Input-Output Structure of the Alberta Economy 1974. Alberta Bureau of Statistics, Alberta Treasury, March 1984. (This approach was adopted through consultation with Wayne Anderson, University of Alberta).

2. Transactions Matrix for the Alberta Economy, 1979, Statistics Canada, Special Computer Printout, 1985.

The total benefits of all alternatives were derived by adding together the benefits of the agriculture production increase and the benefits of the investment component. These total benefits were then reduced by the sum of the total benefits foregone for forestry, hunting and trapping. No attempt was made to measure other costs or benefits foregone associated with such things as increased potential for erosion.

Finally, an underlying assumption to the multiplier analysis applied was that all increased agricultural output would be exported. This simplifying assumption avoids the necessity to determine what proportion of output would be processed and/or used for domestic consumption. It also underestimates to some extent the secondary benefits derived from the increased agricultural output.

1.5 REGIONAL ANALYSIS

The presentation of the Agricultural Land Base Study results on a regional or sub-provincial basis, is an important aspect of this study. Resource management decisions and policies must be based not only on overall provincial impacts but also on their distribution within the province. From an agricultural perspective the soil zones in the province are a useful regional breakdown.

Soil zones were, therefore, used in this and other Agricultural Land Base Study reports as the basis for presenting regional results. For some impacts, such as secondary economic benefits and costs from agricultural development or recreational hunting benefits foregone, regional distribution could not be estimated. Regional results were, therefore, given for direct benefits and costs and general indications of location were made for other impacts.

1.6 IMPACTS ON FORESTRY AND FISH AND WILDLIFE SECTORS

As indicated in Table 1.1, several of the agricultural development alternatives are expected to have an impact on the forestry and fish and wildlife resources and create opportunity costs or lost benefits in those sectors. Four major topics were covered in the analysis of the benefits lost as follows.

1.6.1 Forestry and Forest Grazing

Timber values were determined by Alberta Forest Service for productive and potentially productive forests within the Green Area identified as having agricultural potential. These were based on the underutilization of growing stock volume and incremental growth, during clearing, as well as the loss of future production from the time of clearing to infinity. In addition, forest grazing dispositions within the identified Green Area were evaluated based on carrying capacities and animal unit month values. For other development alternatives, any agricultural benefits that would be lost were netted out of the gains resulting from the specific development. Thus, incremental gains were reported.

1.6.2 Big Game Hunting

Potential ungulate populations of each study area were determined using the Stelfox Ecological Land Classification System and data collected by the Fish and Wildlife Division. The effects of agricultural expansion or intensification were calculated by overlaying the agricultural area and the ecological classification map to determine the potential harvestable population before and after agricultural change.

Once the potential numbers of wildlife before and after agricultural expansion or intensification were determined, the economic effects of agricultural development were determined. The extra market benefits (stated willingness to pay derived from a province wide survey of hunters) and license fees constitute the direct economic benefits. The difference between the pre and post agricultural development benefits was computed to determine the net gain or loss of these benefits. These estimates were provided in the report "ALBS Wildlife Analysis, Economic Component".

Another consideration in the economic analysis was the determination of expenditures in the region lost or gained due to agricultural development. Expenditures can translate into employment in sectors utilized by the hunters in the region. The expenditures before and after agricultural expansion or intensification were also determined and used in calculating secondary economic benefits.

1.6.3 Trapping

Statistics collected by the Fish and Wildlife Division on the registered trapline numbers for a particular region provide the annual income per trapline and the area per trapline. The areas for each trapline were overlayed with the area of agricultural expansion or intensification and the net loss in trapline area computed. Each trapline was evaluated to determine the area lost and the income lost due to agricultural expansion (see ALBS Wildlife Analysis, Economic Component). The approach assumes an even distribution of animals within the trapline areas.

1.6.4 Waterfowl and Upland Game Hunting

Effects of wetland drainage were evaluated for waterfowl and upland game birds in addition to ungulates and aquatic furbearers. These effects are reported in "Calculation of the Effects of Agricultural Drainage on Wildlife". The basic assumption underlying the analyses was that loss of habitat can be used as a predictor of wildlife population loss, and of the economic value of that wildlife. Wetland areas were calculated from data developed during the "Inventory of Alberta's Drainage Requirements (Phase II)" as summarized by Riley's Datashare.

Weighting factors for each wildlife type were derived from habitat suitability models developed for the wetland component of the "Inventory of Alberta's Drainage Requirements (Phase III)" study. Regional annual production estimates were provided by Alberta Fish and Wildlife Division. These were multiplied by the proportion of habitat loss (derived from a comparison of wetlands in the White Area to total wetlands in the White and Green Areas) to estimate the production potential that could be lost as a result of agricultural drainage of all White Area Wetlands, except lakes and ponds.

These production losses were then given an extra market value as for ungulate hunting in other development alternatives. Values are presented in the "ALBS Wildlife Analysis, Economic Component".

In addition to recreational hunting and trapping, agricultural development is likely to have some effect on recreational and commercial fishing, and on non-consumptive and subsistence use of fish and wildlife. These values have not been calculated in this study because of lack of information on the impact of changes in species numbers on benefits derived.

1.7 CAUTIONARY NOTES AND SUMMARY OF ASSUMPTIONS

1. The on-farm benefit analysis is fundamental to evaluating the eleven development alternatives in the ALBS. This economic impact report deals only with the base case (average prices and yields) from that report. There were many underlying assumptions to the on-farm analysis which directly affect the societal results. It must be noted that changes to those assumptions could drastically change the results in the societal analysis. This same caution applies to the estimates of the inventory of land available for development or improvement and the evaluation of benefits foregone.

2. The economic impact analysis was based on the on-farm economic (not financial) analysis. Thus, transfer payments between farmers and the rest of society were not included.

3. The assumptions regarding project life in the on-farm analysis were changed to infinity in this analysis. Essentially, constant input and output relationships (both relative and absolute) were assumed into infinity.

4. A major assumption that all increased agricultural output is exported was made for the societal analysis. Also, at all levels of analysis it was assumed that markets were not a limiting factor and increased output would not change prices.

5. Public investment was a necessary input to create the opportunity for development of some alternatives (Green Area conversion, irrigation expansion and drainage). This public investment was assumed primarily for infrastructure construction costs. These construction costs were used to derive direct value-added and secondary benefits to the economy. It should be noted, however, that with government investment subsequent value-added and secondary benefits would accrue to the economy regardless of the project type. In other words government could allocate dollars in any region for any type of construction and yield the same secondary benefits (secondary benefits may be redistributed rather than additional).

6. Though projects showed positive total benefits in the multiplier or secondary analysis (since costs become benefits to other sectors of the economy) it is still important to consider the direct on-farm analysis when making decisions or conclusions. The reader is urged to use the direct on-farm analysis in conjunction with the societal analysis when drawing conclusions. For Green Area conversion, secondary analysis produced direct value-added benefits of $1,520 million, while on-farm financial analysis shows a B/C ratio of less than 1.0 for the farmer. Similarly, for irrigation the total benefits based on multiplier analysis were positive, while the direct net benefits were negative.

7. Multipliers derived from input-output (I/O) analysis were used to estimate secondary benefits. The multipliers chosen were simple (absolute form, with leakages) by detailed industry for Gross Domestic Product (G.D.P.) at factor cost.

8. The use of I/O derived multipliers assumes a shift in general equilibrium to meet an increase in final demand. The use of these multipliers for constuction costs is allowable given the relatively long phase-in periods. However, if it were decided to shorten the phase-in periods alternate evaluation methods would be needed for construction secondary benefits (i.e. employment models).

9. The multipliers were derived from 1974 ABS I/0 analysis. To adjust for changes in technology and input-output relationships since 1974 the multipliers were modified. This was done using the gross margins derived from the ALBS data (1982) and Statistics Canada 1979 data, in conjuction with the gross margins from ABS tables for 1974.

10. Impacts on other resource uses were evaluated where possible. Impact analysis was done for forestry (Green Area conversion) and wildlife (hunting and trapping). A more qualitative analysis was provided on the physical impact of each alternative in a separate document "The ALBS: Analysis of Impacts on Other Resources."

2. GREEN AREA CONVERSION

2.1 DIRECT NET BENEFITS - GREEN AREA CONVERSION

The Green Area, which corresponds to the forested non-settled lands, is managed primarily for forest production, watershed protection and multiple use, including unimproved grazing. Other agricultural uses have been restricted. The Alberta Department of Forestry, Lands and Wildlife is responsible for the administration and management of these public lands.

Suitable public lands are periodically withdrawn from the Green Area for agricultural development. Canada Land Inventory (CLI) agricultural capability Class 1-4 lands are generally considered suitable for annual field crop production. Most of the development and expansion occurs along the existing Green Area boundary and is primarily located in the Peace River District. While there are approximately 10.8 million acres of potentially arable lands, predominantly located in the Peace River portion of the Green Area, it is estimated that on the basis of physical capability, 9.2 million acres could be brought into agricultural production.

To calculate the net direct societal benefits from Green Area conversion, estimates were determined for net returns from agriculture, off-farm costs and net benefits foregone from other uses. On-farm costs and returns were derived from the report "ALBS Economic and Financial Analysis: Direct Benefits and Costs". Infrastructure costs were determined through consultation with Forestry, Lands and Wildlife, Transportation, Environment, Municipal Affairs and other relevant agencies. Benefits from timber production were determined by the Forestry Service, and hunting and trapping benefits by the University of Alberta and Fish and Wildlife Division.

The original on-farm benefits and costs were based on a project life of 30 years. Sensitivity analysis was done to estimate the residual value of the land beyond 30 years. Forestry estimates were

based on 100 years, while fishing and hunting benefits were estimated on an annual basis. Infrastructure costs were considered to be a single investment with annual maintenance costs. Adjustments were made to the data to account for large acreages and longer project lives.

It was assumed that forestry and related benefits would be sustained into perpetuity if forests were managed as proposed through sustained yield management. Also, the benefits of agricultural land development and of infrastructure provided would be longer term than 30 years if properly maintained. For these reasons, the societal benefits and costs from Green Area conversion were calculated on the basis of sustained or infinite benefits and losses. Infrastructure costs were phased-in to coincide with farm development. Maintenance costs were assumed to be infinite.[1] Forestry and hunting and trapping benefits foregone were also evaluated in terms of infinite streams of benefits and costs.

2.1.1 Agricultural Benefits

Four expansion scenarios were originally examined through the on-farm economic analysis. These were 485 acres cultivated (¼ summerfallow); 960 acres cultivated (¼ summerfallow); 485 acres cultivated (continuous cropping); and 960 acres cultivated (continuous cropping). The larger 960 acre farm with continuous cropping was found to be the most economically feasible and was chosen for further analysis. Financial analysis revealed that with no equity (all investment achieved through loans), the returns to the farmer would be negative, producing an annual equivalent cash flow (AECF) of -$18 per acre. With 30 per cent equity a near break-even position would be achieved. Where transfer payments (including interest payments and subsidies) were removed, expansion was shown to be economically feasible with an AECF of $16 per acre.

To convert the economic results from an individual farm basis with a 30 year time frame to a large scale with an infinite time frame, costs

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1. Periodic upgrading would be needed but was not costed.

and returns were determined beyond year 30. Based on an infinite stream of benefits and costs, the gross output was $1,792 per acre, the net present value (NPV) of each acre developed was $421 and the AECF $21 per acre (before taking phasing into account). Costs measured were on-farm operating and investment costs, including utility installation.

This study was not designed to be a planning or implementation document but to examine the potential economic benefits and costs from maximum development of all land in the Green Area with capability for crop production (9.2 million acres). However, certain practical and technical considerations had to be taken into account when examining such a large acreage. For this reason, phasing-in was assumed to be carried out over 100 years at the rate of 92,000 acres per year. At this rate of phasing-in, the NPV for the total 9.2 million acres was $769 million (Table 2.1). The gross B/C ratio on-farm was calculated to be 1.31, while the net B/C ratio on-farm was 1.78. These were calculated from the ratio of gross value to operating plus investment costs ($3,273/$2,504), and from the ratio of gross value less operating costs to investment costs ($1,758/$989) respectively. The former convention (gross B/C ratio) was adopted in the ALBS Economic and Financial Analysis: Direct Benefits and Costs Report, where the ratio derived was 1.26.

In recent years, the new land made available for agriculture has averaged approximately 20,000 acres annually. The Public Lands Division could probably handle twice this acreage with existing facilities. However, to achieve higher rates of disposition increases in administrative services would be required. The Transportation Department currently provides approximately 75 miles of roads per year in the Peace Region and is unable to service all new farms at the rate at which they are currently developed. It is reasonable to expect that this capacity could be doubled or tripled in the medium term. This would permit the servicing of approximately 200 miles or approximately 50,000 acres per annum. Capacity would therefore have to be increased at lease five fold to achieve the phasing rate assumed.

TABLE 2.1

DIRECT NET BENEFITS FROM GREEN AREA CONVERSION

Acreage (million ac)	Present Value[1] Gross Value	Gross Margin (On-farm)	Investment Cost[2]	Net Value[3]
	($ million)			
9.2	3,273	1,758	989	769

Source: ALBS, Direct Benefits and Costs, new computer runs (1985).

1. The most economically feasible scenario was chosen. Assumes an infinite stream of costs and benefits and phasing-in over 100 years.

2. Phone and gas costs included (not previously included in Direct Benefits and Costs Analysis).

3. Net present value (NPV) represents returns to land, labor, management and existing investment with phasing-in.

Apart from any administrative and budget restrictions on the rate of development, there is the limitation of industry capacity, both in the supply of caterpillars for land clearing and of road building equipment. There is also the restriction placed by the short summer on how much land can be developed and serviced per year. The rate of 92,000 acres per year would require massive funding and expansion of the support industries. While it is feasible for massive expansion in capacity to occur, this would produce significant shifts in the prices paid for the necessary resources. This impact has not been evaluated.

2.1.2 On-Farm Investment and Public Infrastructure Costs

On-farm investment and public infrastructure costs are provided in Table 2.2. These were compiled from various sources and were phased-in to coincide with the on-farm development staging of individual farms (i.e. land development over six years) and the over all phasing over 100 years. Off-farm or public investment on surveys, roads and drains were costed in year one. Power was phased-in over years one to three and other infrastructure costs were phased-in over five years from year six. Certain costs may not be required for all areas identified but were included to estimate maximum potential costs. Annual maintenance costs for roads, drains, hospitals, schools and community and area infrastructure were included to infinity. Total on-farm investment was $989 million (already deducted in calculation of NPV on-farm). Public infrastructure costs totalled $273 million and maintenance costs were $258 million.

It is emphasized that the figures presented should be interpreted with caution. In the absence of defined areas for the proposed expansion the data obtained are rough estimates based on existing infrastructure. Values are based on averages for the Peace River region and actual values may vary considerably given the size of areas considered and the range of possible conditions. With regard to power, gas and telephone supply, actual costs will depend on the topography of the given area, its access to existing supply centres, the load on this system, layout of farms,

TABLE 2.2

ON-FARM AND PUBLIC INVESTMENT COSTS FOR GREEN AREA CONVERSION

Category	Cost/Acre Cultivated	---Present Value--- Before Phasing	After[6] Phasing	Total PV 9.2M Acres ($ million)
	------------ ($/acre)	------------		
On-Farm Investment				
Land Development[1]	230.00	198.00	39.30	361
Equipment		320.00	63.50	584
Power[2]	8.46	7.68	1.50	
Phone	10.35	7.02	1.40	
Gas	14.24	9.66	1.90	44[7]
Total On-Farm		542.36	107.60	989
Public Investment				
Surveys[3]	7.06	6.72	1.30	
Roads	111.76	106.44	21.10	
Drainage	24.71	23.53	4.70	
Power	4.48	4.07	0.80	
Schools[4]	5.43	3.51	0.70	
Hospitals	2.76	1.78	0.40	
Community Infr.	5.43	3.69	0.70	
Total	161.64	149.75	29.70	273
Maintenance[5]				
Roads & Drains	4.71	85.36	16.90	
Schools & Hosp.	2.88	40.97	8.10	
Community Infr.	1.00	14.92	3.00	
Total	8.59	141.25	28.00	258
Total Public Investment				531

Source: Compiled by Production and Resource Economics Branch, Alberta Department of Agriculture through consultation with other departments and agencies.

1. Land development phased-in over 6 years.
2. Power phased-in over 3 years (42% of costs subsidized).
3. Surveys, roads and drains costed in year one of project.
4. Other infrastructure phased-in over five years from year six (including telephone and gas).
5. Annual maintenance costs assumed to be ad infinitum.
6. Phased in at 92,000 acres per year (over 100 years).
7. Power, phone and gas.

and other factors. The need for schools, hospitals and recreational facilties will depend on proximity to existing centres and on the degree of excess capacity in these centres.

Other infrastructure costs include those for the provision of medical, educational and recreational facilities. Studies of three northern regions (Big Bend, Frost Hills and Northwestern Alberta) suggest that no additional infrastructure costs would be required to provide medical and educational services, since the present excess capacity in hospitals and schools can accommodate the projected increase in population. While acknowledging that recreational facilities might have to be expanded in some areas, none of the project proposals quantified expenditure resulting directly from agricultural expansion. It was noted, however, that excess capacity did exist at some facilities and that there were plans for enhancing facilities in some locations. This may not apply to all areas identified therefore cost estimates for schools, hospitals and community and area infrastructure have been included in this study. The cost estimates for individual items are as follows.

1. Roads. Estimates available from Public Lands for the construction of new roads (including secondary and local gravel roads) vary considerably by location and conditions. In consultation with Transportation, it was decided that $95 per acre was a reasonable estimate for construction of new roads. Maintenance costs were estimated at $1,500 per km per year or $3 per acre served.

2. Power. Installation of power lines, transformers and anchors was estimated to cost $11,000 per 1,000 acre farm unit, including $1,000 for upgrading prior to development. This produced a cost of $11 per acre.

3. Gas. For a new area the costs of hooking up natural gas supply was estimated at $11,000 per farm unit. Prior upgrading was calculated at 10% of installation costs or $1,100 per farm unit, for a total of $12,100 or $12.10 per acre.

4. Telephone. Assuming a buried cable, the cost of installation was estimated at $8,000 per farm unit, plus $800 for prior upgrading. The per acre cost would be $8.80.

5. Surveys. Energy and Natural Resources carries out legal surveys and soil surveys, which are costed at $5.31 per acre served for the former (based on an average contract cost of $1,700 per mile) and $0.72 per acre for the latter, totalling $6.00 per acre. The administrative costs would be minimal.

6. Drainage. Estimates of drainage costs were obtained from three sources. The estimates range from $40 to $100 per acre. In consultation with Public Lands Division, an average of $63 per acre was agreed upon. Maintenance costs range from $1 to $3 per acre per year and periodic upgrading from $0.50 to $1.50 per acre per year. An average of $3 per acre was allocated to cover these costs. It was assumed that one-third of the area would require some drainage, therefore, average costs of $21 for infrastructure and $1 per acre for maintenance were applied to the project.

7. Schools. Estimates were provided from the Department of Education for four school divisions vis Peace River, Fairview, Ft. Vermilion and Northland. The average for 1982 was $1,303.50 per capita. Assuming an average farm family of four, this converts to $5,214 per farm. For each 960 acres cultivated the per acre cost is therefore $5.43. Average maintenance costs were $444.99 per capita. This represents a per acre cost of $1.85.

8. Hospitals. Hospital costs were based on costs provided for Ft. Vermilion where a new hospital was built in 1983-84, and therefore may be closest to the costs of a developing farming area. The average capital costs for the years 1983 and 1984 were $663 per capita and the average operating costs were $290 per capita. These convert to per acre costs of $2.76 and $1.21 respectively.

9. Community and Area Infrastructure. A cost of $50 million was estimated by Municipal Affairs. This cost would cover the provision of community water and sewer services, and garbage disposal, fire protection, recreation programs and facilities, and agricultural services necessary for the expanding agricultural area. This cost was phased-in over five years as for other infrastructure. Maintanence costs were estimated at $1.00 per acre per year.

It must be noted that the capital and operating costs for community and area infrastructure do not include costs for the development of new regional communities and service centres (such as La Crete or Manning). Major expansion and extension of existing regional centres is not included. Also, marketing infrastructure expansion was not considered.

It should be recognized that this study did not attempt a complete socio-economic analysis of Green Area conversion. The possible impact on existing communities was not examined nor were the factors relating to life style and quality, expectations and philosophical factors associated with homesteading. This study did not examine the demand for land nor the availability of off-farm jobs. It is obvious that land development is greatly dependent on both of these latter factors. Finally, the availability and cost of capital was not examined. It was assumed that funds would be available under existing conditions.

Public investment costs (with the exception of schools, hospitals and community and area infrastructure) were estimated on a per total acre, rather than a per cultivated acre basis. In order to bring them into line with the estimates of direct and secondary net benefits, they were converted to the latter basis using the expected ratio of cultivated to total acreage in the development of Green Area Lands for agriculture. Estimates vary considerably, but personal communication with staff from the Public Lands Division and Alberta Agriculture field staff would suggest that an 85% ratio of cultivated to total acreage might be expected. This was the ratio used in the ALBS Agricultural Inventory report and was used here to convert to a cultivated acre basis.

The NPV, after deducting public infrastructure costs from the net on-farm benefits, was $238 million or $26 per acre. The gross B/C ratio fell from 1.31 on-farm to 1.01 ($3,273/$3,035). The net B/C ratio fell from 1.78 on-farm to 1.16 ($1,758/$1,520).

2.1.3 Forestry Benefits Foregone

Approximately 10.8 million acres of CLI Class 1-4 lands (predominately CLI Class 4) were identified as existing in the Green Area. CLI data were derived at a reconnaissance level and were intended for broad level planning. The above estimate was therefore reduced by 15% to 9.2 million acres to account for land with physical landscape limitations. This reflects the current proportion of land which is not posted for agricultural use when Green Area land is withdrawn for agricultural development.

For the same area, the Alberta Forest Service identified 8.76 million acres by the AFS-AFORISM run. This represents an 84% adjustment from a total of 10.43 million acres in the Green Area. The difference of 434,456 acres between the Agriculture estimate of 9.2 million acres and the Forestry estimate of 8.76 million acres can only be explained by differences in the methods and accuracy of measurement used by each agency.

Of the 8.76 million acres identified by Forestry, 65.4% or 5.73 million acres were described as productive, with current annual allowable cut (AAC). Another 3.3% or 291,951 acres were potentially productive. This potentially productive area is defined as present immature timber or stands which could produce benefits in the near future. The remaining 31.3% or 2.74 million acres was described as non-productive forest land. This includes water, muskeg, treed muskeg, scrub-coniferous or deciduous, sand, rock barren, soil barren, grassland and cleared land (permanent clearing). Again, the discrepancy between the Forestry and Agriculture estimates of unproductive land is due to differences in measurement techniques.

For purposes of this study (because of the large acreage involved) phasing-in of agriculture was assumed to be done over 100 years, at a rate of 92,000 acres per year. With this long time frame, it was assumed that adjustments could be made to forest harvesting operations to coincide with the rate of agricultural development. Thus, on any given block of land it was assumed that normal cutting would be carried out until the land was phased-in for agricultural use. Forest benefits would therefore be lost from the year the forest was removed for agricultural development. There would also be a salvage timber value in that year only. Therefore, both the benefits lost and the salvage values were discounted from the year of removal to the present.

The estimates of forest values provided by AFS were based on 8.76 million acres, with productive forest occupying 5.73 million acres and potentially productive forest 291,951 acres. Values were estimated by forest area and species. Forest timber values were calculated from stumpage values for the productive forest area covered by the study (characterized by the historical and current use of timber). Stumpage values are essentially the net difference between gross timber product values and the cost of production per unit of standing (green) timber volume. Stumpage values vary according to species (coniferous vs. deciduous) and the end product.

Net present values (NPV) for productive and potentially productive forests and for timber that could be utilized (salvaged) during clearing for agricultural use, are provided in Table 2.3. The values for productive forests comprised two parts. The first part was based on cutting 1/100 (one percent) of the growing stock volume, plus the incremental growth for the declining balance of growing stock, every year for 100 years. This value was estimated at $1.49 billion.

The second part comprised benefits that would normally accrue from the time of cutting growing stock (assuming replanting), to infinity. This value was $178 million. Thus, the sum of these values represented the full value of the existing productive forest ($1.66 billion).

TABLE 2.3

TIMBER RESOURCE VALUES[1] IN GREEN AREA IDENTIFIED FOR POTENTIAL CONVERSION

Forest	Species Group	Productive Area Identified (acres)	Net Present Value of Forest	Net Present[2] Value of Salvage	NPV of Benefit Foregone (with salvage)
			($'000)		
Edson					
	Coniferous	5,110	1,048	482	566
	Deciduous	5,962	2,951	1,069	1,882
	Pot. Productive	502	16	-	16
	Total	11,574	4,015	1,551	2,465
Footner Lake					
	Coniferous	421,987	99,736	45,333	54,403
	Uncom. Decid.	1,065,972	191,642	68,775	122,868
	Pot. Productive	23,349	452	-	452
	Total	1,511,308	291,830	114,108	177,722
Grande Prairie					
	Coniferous	319,681	168,227	74,739	93,488
	Deciduous	587,538	221,453	77,904	143,549
	Uncom. Decid.	202,095	50,559	18,548	32,011
	Pot. Productive	46,171	2,066	-	2,066
	Total	1,155,485	442,305	171,191	271,114
Lac La Biche					
	Coniferous	89,866	21,691	9,764	11,928
	Uncom. Decid.	112,898	28,692	10,248	18,444
	Pot. Productive	18,709	483	-	483
	Total	221,473	50,866	20,012	30,855
Peace River					
	Coniferous	163,128	52,753	24,248	28,506
	Deciduous	117,316	32,703	11,748	20,955
	Uncom. Decid.	431,035	110,118	39,360	70,758
	Pot. Productive	17,426	473	-	473
	Total	728,905	196,047	75,356	120,692
Rocky-Clearwater					
	Coniferous	8,799	2,459	1,080	1,380
	Deciduous	30,301	8,072	2,898	5,174
	Pot. Potential	732	21	-	21
	Total	39,832	10,552	3,978	6,574
Slave Lake					
	Coniferous	458,698	162,906	72,685	90,220
	Deciduous	458,671	139,938	50,307	89,631
	Uncom. Decid.	477,114	134,223	47,939	86,285
	Pot. Productive	148,279	4,900	-	4,900
	Total	1,542,762	441,967	170,931	271,036
Whitecourt					
	Coniferous	364,700	147,608	64,192	83,416
	Deciduous	143,442	41,194	14,524	26,670
	Uncom. Decid.	266,973	65,322	23,420	41,902
	Pot. Productive	36,782	1,465	-	1,465
	Total	811,897	255,589	102,136	153,457
TOTALS					
	Coniferous	1,831,969	639,073	271,962	367,111
	Deciduous				
	-Committed	1,343,230	446,311	158,450	287,861
	-Uncommitted	2,556,087	580,557	201,112	372,267
	Dec. Subtotal	3,899,317	1,026,868	359,562	660,128
	Pot. Productive	291,950	9,876	-	9,876
TOTAL		6,023,236	1,675,817	631,524	1,037,116

Source: Alberta Forest Service.

1. Includes potentially productive acreage, evaluated only beyond 100 years (i.e. next forest cycle).

2. Assumes that 50% of coniferous and 40% of deciduous volumes would be harvested during agricultural expansion.

No value was given to standing potentially productive forests. The values for these forests were based on future production, calculated in a similar manner to the future benefits of productive forest (after cutting and replanting). The value of potentially productive forests was $9.9 million, giving an NPV for productive plus potentially productive forests equal to $1.67 billion.

The salvage value was based on the productive forests being partially utilized during clearing for agricultural development. Of the timber removed, only part of the full value of that timber would be realized due to utilization, production and market constraints. The salvage value assumed that 50% of coniferous and 40% of deciduous volumes would be utilized in some productive form and their values would accrue to the Alberta economy. It was assumed that the forest products industry would be able to alter normal cutting operations to utilize the timber removed in such development, and that this would be done prior to farm development.

The value that would be realized was estimated at $631 million. The NPV of benefits foregone from agricultural expansion was derived as the difference between the full value of the productive and potentially productive forests ($1.67 billion) and the salvage value ($631 million). This was equal to $1.04 billion.

Gross values of forest benefits foregone were required for the multiplier analysis. These are presented in Table 2.4 The gross present value of benefits from 5.7 million acres of productive forest would be $16.53 billion. The equivalent value for potentially productive forest would be $200 million, producing a total value of $16.73 billion. The gross salvage value of the productive forest would be $6.55 billion. Thus, the benefit foregone would be $10.18 billion.

2.1.4 Forest Grazing Benefits Foregone

In addition to the lost timber revenue, the expansion of cultivation into Green Area lands will reduce forest grazing dispositions. It has

TABLE 2.4

GROSS BENEFITS FOREGONE FROM GREEN AREA CONVERSION[1]

Forest	Species Group	Productive Area Identified (acres)	Gross Present Value ($'000)	Gross PV Foregone (with salvage) ($'000)
Edson				
	Coniferous	5,110	11,229	6,067
	Deciduous	5,962	27,543	17,567
	Pot. Productive	502	160	159
	Total	11,574	38,933	23,793
Footner Lake				
	Coniferous	421,987	1,069,120	583,170
	Uncom. Decid.	1,065,972	1,732,353	1,110,664
	Pot. Productive	23,349	4,348	4,324
	Total	1,511,308	2,805,821	1,698,158
Grande Prairie				
	Coniferous	319,681	1,536,788	854,034
	Deciduous	587,538	2,144,333	1,389,990
	Uncom. Decid.	202,095	489,544	309,951
	Pot. Productive	46,171	19,569	19,595
	Total	1,155,485	4,190,234	2,573,569
Lac La Biche				
	Coniferous	89,866	232,529	127,861
	Uncom. Decid.	112,898	264,147	169,797
	Pot. Productive	18,709	4,766	4,745
	Total	221,473	581,432	302,403
Peace River				
	Coniferous	163,128	495,199	267,585
	Deciduous	117,316	307,489	197,032
	Uncom. Decid.	431,035	1,035,426	665,331
	Pot. Productive	17,426	4,446	4,445
	Total	728,905	1,842,559	1,134,393
Rocky-Clearwater				
	Coniferous	8,799	26,363	14,788
	Deciduous	30,301	77,255	49,518
	Pot. Potential	732	207	207
	Total	39,832	103,825	64,512
Slave Lake				
	Coniferous	458,698	1,746,266	967,114
	Deciduous	458,671	1,259,641	806,805
	Uncom. Decid.	477,114	1,208,201	776,684
	Pot. Productive	148,279	47,225	47,053
	Total	1,542,762	4,261,333	2,597,656
Whitecourt				
	Coniferous	364,700	1,794,818	1,014,285
	Deciduous	143,442	414,413	268,300
	Uncom. Decid.	266,973	657,149	421,534
	Pot. Productive	36,782	16,483	16,459
	Total	811,897	2,882,853	1,720,578
TOTALS				
	Coniferous	1,831,969	6,912,303	3,834,904
	Deciduous			
	-Committed	1,343,230		
	-Uncommitted	2,556,087		
	Dec. Subtotal	3,899,317	9,617,484	6,182,115
	Pot. Productive	291,950	200,818	161,292
TOTAL		5,731,286	16,730,605	10,178,311

Source: Alberta Forest Service.

1. Includes potentially productive acreage, evaluated only beyond 100 years (i.e. next forest cycle).

been estimated by the Alberta Forest Service that forage for 20,486 animal unit months (AUM's) will be lost on a total of 88,097 acres. Over a 100 year development period, this is equivalent to a loss of 881 acres or 205 AUM's of grazing per year. The methodology described for timber loss and values provided by Alberta Forest Service were used to calculate benefits foregone from forest removal. The gross value of the grazing loss was based on the number of AUM's and the value of $47.07 per AUM. This gross value was $3.8 million. An annual equivalent cash flow of $3.36 per acre was used to determine the net present value of the lost grazing resource at $1.1 million (Table 2.5).

2.1.5 Big Game Hunting and Trapping Benefits Foregone

Values for hunting benefits foregone were derived from various Alberta hunter surveys. They were based on numbers of hunters and the willingness of hunters to pay for the hunting experience (including the cost of the hunting license). The assumption was made that any decrease in wildlife numbers would be matched by a decrease in permitted hunter days and that the value of such a day would be unchanged. These estimates are provided in Table 2.6. If the total 9.2 million acres were cleared, the total annual reduction in benefits would be $3.6 million.

Trapline benefits foregone were based on the number of trapline areas affected, the degree of disruption and whether the lines would be abandoned or not. The gross fur value associated with areas disrupted or abandoned over the entire 9.2 million acres was estimated at $735,542 per annum (Table 2.7).

The total values for hunting and trapline benefits foregone were converted to an acreage basis. The acreage value was expressed as a PV based on an infinite period. The values were $7.85 and $1.60 per acre for hunting and trapping respectively. The present value per acre was then used to estimate the total value foregone from 9.2 million acres, using the phasing period applied to agriculture. The hunting benefit

TABLE 2.5

FOREST GRAZING BENEFITS FOREGONE FROM GREEN AREA CONVERSION

GROSS VALUE

Total AUM's Lost	AUM's Lost/Year	Gross Value ($/AUM)	PV Phased-In (100 yrs.)
20,486	205	47.07	3,827,790

NET VALUE

Total Acres Lost	Acres/Year	NPV/Acre ($)	PV Phased-In (100 yrs.)
88,097	881	63.50	1,110,399

Source: Alberta Forest Service.

TABLE 2.6

HUNTING BENEFITS FOREGONE FROM GREEN AREA CONVERSION

Animal Type	No. of Hunters	WTP[1]/Day /Hunter	# of Days /Hunter	Total Benefits ($'000)	% Change Benefits ($'000)	WTP Benefits Foregone[2] ($'000)	Expenditure[3] Foregone ($'000)
Moose	63,971	34.64	9.0	17,056	-24.2	4,122	6,798
Elk	33,036	29.97	9.9	5,139	- 5.2	269	506
White Tail Deer	74,603	35.85	8.8	13,583	+16.0	(2,178)	(3,463)
Mule Deer	58,726	30.67	9.8	8,118	- 4.7	378	698
Black Bear	14,878	35.91	8.8	3,396	-30.1	1,022	1,626
Total Annual Benefit						3,613	6,164
Annual Benefit/Acre						$0.39	$0.67
P.V. Benefit/Acre (infinity)						$ 7.85	$13.40
P.V. Benefit for 9.2M Acres ($ million)						14.3	24.5

Source: ALBS Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Willingness to pay, including hunting licence value.

2. Benefits added re: white tail deer.

3. Based on hunter expenditure of $55.68 per day derived from resident hunter survey summarized in W. Phillips, D. De Pape and L. Evanyk "A Socio-economic Evaluation of the Recreational Use of Fish and Wildlife Resources in Alberta, With Particular Reference to the AOSERP Study Area", AOSERP Report 43, Edmonton, Alberta. Oil Sands Environmental Research Program, December, 1978.

TABLE 2.7

DIRECT TRAPLINE BENEFITS FOREGONE FROM GREEN AREA CONVERSION

Area	Number of Areas	Gross Fur Value Foregone ($)
Areas less than 40 percent affected	390	170,683
Areas more than 40 percent affected[1]	304	564,859
Total Annual Benefit	694	735,542
Benefit/Acre (infinity)		$1.60
P.V. Benefit for 9.2M Acres ($ million)		2.9
P.V. Gross Margin ($ million)[2]		2.3

Source: ALBS Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Based on 50% of area abandoned and 50% not abandoned (if areas with more than 40% disrupted are abandoned the loss would be $675,112; if not abandoned the loss would be $454,607).

2. Gross margin percentage assumed to be 78.11% (taken from Table 1.3).

foregone was estimated at $14.3 million. The gross value of trapping benefits foregone were $2.9 million, while the net (gross margin used as a proxy) was $2.3 million.

2.1.6 Direct Net Societal Benefits

The direct benefits and costs (including benefits foregone) are summarized in Table 2.8. These estimates are based on sustained yields in each sector examined, and reflect the total gains and losses associated with agricultural development of 9.2 million acres in the Green Area. From Table 2.1 it was seen that the on-farm NPV for 9.2 million acres was $769 million. Thus, the direct net agricultural benefits would cover the public infrastructure costs of $531 million.

The gross and net B/C ratios were 1.01 and 1.16 respectively and the NPV was $26 per acre before deducting benefits foregone.[1] However, benefits foregone from other uses would be $1,054 million. These would not be covered by net agricultural benefits. The gross and net B/C ratios fell to 0.80 and 0.68 respectively and the NPV to -$89 per acre, after deducting benefits foregone.

The direct benefit analysis revealed that the current direct forestry and wildlife benefits would be greater than the net direct benefits of agriculture after deducting infrastructure costs. The present value of the direct forestry, hunting and trapping benefits were $115 per acre while the direct net benefits for agriculture, after infrastructure costs, would be $26 per acre.

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1. Gross B/C ratio = Gross Revenue / (Operating + Investment Costs + Benefits Foregone, when included).

   Net B/C ratio = (Gross Revenue - Operating Costs) / (Investment Cost + Benefits Foregone, when included).

   The Gross B/C convention was used in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report.

TABLE 2.8

DIRECT NET BENEFITS TO SOCIETY FOR GREEN AREA CONVERSION

Present Value[1]					
Gross Margin[2]	Investment[3] On-Farm	Investment[3] Public	- Benefits Foregone - Forestry[4] &Grazing ($ million)	- Benefits Foregone - Hunting[5] &Trapping	NPV (To Society)[6]
1,758	989	531	1,038	16	(816)

1. PV's relate to the phasing-in rate of 92,000 acres per year.

2. Gross margin assumes a sustained or infinite stream of benefits and costs (all operating costs deducted). Taken from Table 2.1.

3. Includes capital costs and maintenance costs (ad infinitum). Taken from Table 2.2.

4. Net present value based on an infinite stream of timber benefits and costs, less a salvage value for timber utilized during clearing. Includes $1 million of grazing benefits. Taken from Table 2.3 and Table 2.5.

5. Values taken from Table 2.6 and Table 2.7. Includes $2 million of trapping benefits.

6. Final NPV equals gross margin less investment costs and benefits foregone.

2.1.7 Other Impacts Not Evaluated

Other possible impacts of Green Area conversion which have not been evaluated in this analysis include recreational and commercial fishing, subsistence use of wildlife and possible soil and water degradation. Values for fishing and subsistence use of wildlife have not been included because of a lack of information on the impact of changes in species' numbers on benefits derived.

Although it was discussed more thoroughly in the ALBS: Analysis of Impacts on Other Resources study, the possible impact of erosion due to Green Area conversion needs to be recognized. Soil degradation from wind and water is likely to have an impact on long term agricultural productivity in northern Alberta, just as it does elsewhere. To date the extent or costs of erosion has not been evaluated. It is, however, known that the impact of erosion extends beyond the farmers' fields. Much of the soil removed as a result of wind or water erosion eventually finds its way into water courses where it affects water quality and may subsequently have an impact on fish habitat, recreational use, potable water supplies, and other uses. The cost to society of such degradation may well be many times the cost of productivity losses to producers.

Some probable positive impacts of agricultural expansion have not been investigated. These would include the benefits of a road system and other infrastructure to the petroleum, tourism and other industries in the region.

2.2 SECONDARY AND TOTAL BENEFITS - GREEN AREA CONVERSION

Development projects of this nature can create significant spin-off benefits throughout the provincial economy and beyond. These possible benefits are examined in this section. To measure the secondary benefits gained or lost from Green Area conversion, simple Gross Domestic Product (G.D.P.) at factor cost multipliers were used.

For the "Agriculture Industry" the multiplier used was 0.870 and for the investments in land development and infrastructure the "Construction Industry" multiplier of 0.661 was applied. For machinery and equipment investment the "Wholesale and Retail Industries" multiplier of 0.880 was adopted. The "Wood Industries" multiplier of 0.617 was used to measure secondary benefits foregone from timber production. The "Fishing, Hunting and Trapping" multiplier of 0.945 was used for trapping, and for hunting an average of the multipliers for the "Wholesale and Retail" and the "Food and Accommodations" Industries of 0.839 was applied.

The 1982 ALBS gross margins for agriculture and forestry were used to adjust the 1974 Alberta Bureau of Statistics (ABS) value-added coefficients. The 1974 ABS data for other industries was adjusted by 1979 Statistics Canada data. The procedure for adjusting the 1974 provincial data for the ALBS 1982 data was explained in the Introduction.

Results are presented in Table 2.9. For the 9.2 million acres cleared, benefits from increased agricultural output (direct plus indirect) totalled $2,368 million. Total benefits derived from the investment activities on-farm and off-farm were $1,054 million, made up of $544 million derived from the increased demand for construction activities and $510 million for farm machinery and equipment. The total benefits from all activities were $3,422 million. The benefits lost through the removal of forests were $5,323 million for timber (made up of $2,723 million from direct benefits and $2,600 million from indirect benefits) and $40 million for hunting, trapping and grazing, totalling $5,363 million. Thus the benefits gained were $1,941 million below those lost.

Since the value-added foregone was greater than that gained there was a reduction in GDP at factor cost of $1.28 per $1.00 of investment. Expressed in a ratio form it would be -1.28, for the total value-added (direct and indirect less the value-added foregone) to the total investment (on and off-farm). This is largely a reflection of the loss of the forestry resource and indicates that the growth in the economy produced by agricultural expansion does not compensate for the loss due to forestry removal.

TABLE 2.9

SECONDARY AND TOTAL BENEFITS FROM GREEN AREA CONVERSION

Industry or Activity	Present Value 9.2 M Acres Gross -(million $)-	Present Value 9.2 M Acres G.M.[1] -(million $)-	Modified Multiplier[2]	Present Value 9.2M Acres Secondary --- (million $) ---	Present Value 9.2M Acres Total --- (million $) ---
Benefits Gained					
Agriculture	3,273	1,758	0.724	610	2,368
Land Development	361	144	0.581	65	210
Equipment	584	397	0.873	112	510
Utilities	44	18	0.581	8	26
Public Investment	531	212	0.581	96	308
Total Investment	1,521	772	--	282	1,054
Total Benefits Gained		2,530		892	3,422
Benefits Foregone					
Timber[3]	10,178	2,723	0.523	2,600	5,323
Hunting WTP[4]	14	14	--	--	14
Hunting EXP	24	15	0.839	5	21
Trapping	3	2	0.843	0.2	2
Lost Grazing	4	2	0.803	0.8	3
Total Benefits Foregone		2,756		2,606	5,363
Change In Benefits		(226)		(1,714)	(1,941)

1. Gross margins derived using the gross margin percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. Timber value foregone net of timber harvested during clearing. Derived from Table 2.4.

4. Hunting benefits derived from Table 2.6. Based on willingness to pay (WTP) and expenditure (EXP) estimates. No secondary benefits associated with WTP.

3. IRRIGATION EXPANSION

3.1 DIRECT NET BENEFITS - IRRIGATION EXPANSION

The "ALBS Economic and Financial Analysis: Direct Benefits and Costs" report indicated that in many areas of southern Alberta changing from dryland to irrigation farming should be economically and financially feasible to farmers. Substantial increases in crop and livestock production could be realized while using more labor and more capital per acre than in dryland farming. Even with the substantial increases in costs, the increases in gross revenues would be sufficient to make the change to irrigation profitable to farmers.

Various estimates were used in the calculation of direct net benefits from irrigation expansion. These included on-farm costs and returns derived from the report "ALBS Economic and Financial Analysis: Direct Benefits and Costs"; infrastructure costs provided by Alberta Environment from the "South Saskatchewan River Basin Scenario Report"; and benefits foregone from "ALBS Wildlife Analysis, Economic Component".

The original on-farm analysis and benefit foregone calculations were based on a project life of 30 years. As with other alternatives these results were converted to an infinite period and rehabilitation and/or reinvestments in infrastructure and sprinkler systems were assumed.

There would be substantial economic impacts beyond the farm gate with a change from dryland to irrigation farming. The situation where more inputs are required and more output is produced will generate greater activity in those sectors of the economy which have strong linkages to agriculture. Agricultural processing, farm equipment, transportation and several other sectors can benefit directly from increased irrigation activity. The other very significant activity is the provision of infrastructure and the resulting operations and maintenance which are required to divert, store and distribute water.

Providing water for irrigation involves a very large public sector component. Over time the provincial government has become more involved and gradually assumed much of the earlier federal responsibility for storing and diverting water. The Irrigation Districts play a role in financing and maintaining distribution facilities.

3.1.1 Agricultural Benefits

Approximately 8.9 million acres of land in southern and eastern Alberta have fair to good potential for irrigation in terms of their physical characteristics. However, water availability within this region is the major limiting factor for irrigation expansion. The 1984 South Saskatchewan River Basin Study (SSRB) by Alberta Environment reported on several irrigation development possibilities. Both intensification within existing irrigation districts and extension of irrigation to dryland outside of the present irrigation districts were considered.

The ALBS Direct Benefits and Costs analysis examined two irrigation sub-options each based on 10,000 acre blocks of new irrigated land. The extension/intensification sub-option assumed an adoption rate of 10 years and the expansion sub-option assumed a 20 year adoption rate. The results of financial analysis showed that conversion from dryland to irrigation would produce increased annual cash flows to the farmer equal to between $23 and $130 per acre, depending on climatic zone. Removal of all transfer payments produced economic cash flow increases of between $41 and $178 per acre per annum.

These two sub-options were coupled with the maximum expansion possibility from the South Saskatchewan River Basin study. Maximum expansion predicted that a maximum of 2.3 million acres could be irrigated with existing water supplies. Approximately 1.2 million acres are currently irrigated, leaving a balance of 1.1 million acres for irrigation expansion. Maximum irrigation expansion assumes that the maximum acreage will be irrigated through the extension of the works of existing irrigation districts, with any remaining water placed in "new"

districts. For comparison, analysis was also provided on a smaller scale (maximum district expansion) with most of the development occurring in existing irrigation districts, on approximately 574,000 acres. These results are provided in conjunction with those for maximum expansion.

For on-farm economic evaluation maximum expansion was represented by 67% expansion acres and 33% extension acres. The results of the net on-farm benefits are presented in Table 3.1. Before phasing, the average NPV per acre ranged from $1,020 to $3,823, depending on climatic zone. The new irrigated acreage was phased-in from year 1 to year 100 at a rate of 11,390 acres per year. The respective adoption rates of 10 or 20 years for expansion and extension were reflected in the phasing-in. The on-farm NPV for the total (maximum expansion) acreage considered was $503 million. This was based on a gross margin of $639 million and on-farm investment costs of $136 million. The corresponding net benefit for the maximum district expansion was $411 million, based on a gross margin of $526 million and on-farm investment costs of $115 million.

For maximum expansion the gross B/C ratio on-farm was 1.96 ($1,027/$524) while the net B/C ratio was 4.70 ($639/$136). With maximum district expansion, the gross and net B/C ratios were 1.94 ($848/$437) and 4.57 ($526/$115) respectively. The gross B/C ratios derived in the ALBS Economic and Financial Analysis: Benefits and Costs Report were between 1.62 and 2.35, depending on climatic zone.

3.1.2 Investment Costs

Costs for off-farm infrastructure are presented in Table 3.2. Public infrastructure expenditure on storage and headworks was phased in from year one to year 65 for maximum expansion (the first 574,000 acres being served by infrastructure put in during the first ten years). The PV of total capital infrastructure costs was $1,532 million and that of operating and maintenance $115 million, giving a total public cost of $1,647 million. The corresponding values for maximum district expansion were $1,367 and $106 million respectively, giving a total of $1,473

TABLE 3.1

DIRECT NET BENEFITS FROM IRRIGATION EXPANSION[1]

Irrigation Climatic Zone	Acreage ('000 ac)	Present Value[2] Gross Value	Gross Margin	Investment[3] Cost	Net Value (On-farm)
		(million $)			
Maximum Expansion					
A1	233	253	167	23	144
A2	523	454	284	53	231
B	17	18	11	3	9
C	366	301	177	28	119
Total	1,139	1,027	639	136	503
Maximum District Expansion					
A1	86	193	127	17	110
A2	207	356	222	42	181
B	11	17	11	2	8
C	270	282	166	54	112
Total	574	848	526	115	411

Source: ALBS: Direct Benefits and Costs - new computer runs (1985).

1. Maximum expansion chosen from SSRB report and used in ALBS Agricultural Inventory report. Maximum district expansion results provided for comparison.

2. All PV's reported are for infinite streams of benefits and costs and after phasing-in at 11,390 acres per year from year 1 to year 100. Year 1 to year 50 for district expansion.

3. Reinvestment in sprinkler equipment every 15 years.

TABLE 3.2

PUBLIC INFRASTRUCTURE COSTS FOR IRRIGATION EXPANSION

Category	Present Value Maximum Expansion (million $)	Present Value District Expansion (million $)
Public Investment[1]		
Storage & Headworks	888	751
New District Works	28	
Rehabilitation	616	616
Total Capital	1,532	1,367
O and M Costs[2]	115	106
Total Capital & Operating & Maintenance	1,647	1,473

Source: Derived from SSRB Scenario Report, Alberta Environment (new computer runs, 1985).

1. Reflects phasing-in of infrastructure for first 574,000 acres over 10 years and the remainder from year 46 to year 65, with rehabilitation work from year 1 to year 30.

2. Operating and maintenance costs assumed to year 100.

million. This relatively high cost for district expansion reflects capital costs in the first 10 years, producing a high present value. The fairly marginal increase for maximum expansion reflects additional capital costs (in years 46 to 65) which were greatly discounted.

With maximum expansion the NPV after deducting public infrastructure costs was -$1,144 million or -$1,004 per acre. The gross B/C ratio fell from 1.96 to 0.47 ($1,027/$2,171), while the net B/C ratio fell from 4.70 to 0.36 ($639/$1,783). The corresponding ratios for maximum district expansion were 0.44 ($848/$1,910) and 0.33 ($526/$1,588) respectively.

3.1.3 Big Game Hunting Benefits Foregone

Values for direct hunting benefits foregone were derived on the basis of the reduction in the number of hunter days and the hunters' willingness to pay for the hunting experience (as described for Green Area conversion). This is a willingness to pay over and above actual expenditure and is therefore used as a proxy for the net benefit to the hunter.

Analysis was based on the expected benefits that would be lost from irrigating 1.1 million acres of dryland. The total annual loss was estimated to be $1,402,600 (Table 3.3). This produced a simple average of $1.27 per acre. When converted to an infinite basis, the present value of benefits foregone was $25.50 per acre. With phasing, (1.1 million acres), as described for agriculture, the total loss would be $5.8 million. These estimates were extrapolated for the smaller acreage under maximum district expansion and produced a total loss of $5.3 million. This latter estimate assumes a linear relationship between acreage and value foregone. If the relationship is not linear the benefit foregone for district expansion would vary from the estimate.

Expenditure values were also estimated, on the basis of $55.68 per day, derived from a resident hunter survey. The analysis was repeated as for the willingness to pay estimates and provided a PV of $40.50 per

TABLE 3.3

HUNTING BENEFITS FOREGONE FROM IRRIGATION EXPANSION[1]

Animal Type	# of Hunters	WTP[2]/Day /Hunter	# of Days /Hunter	Total Benefits ($'000)	% Change Benefits	WTP Benefits Foregone ($'000)	Expenditure[3] Foregone ($'000)
Antelope	5,055	34.45	3.00	522	-22.0	114.9	185.8
Mule Deer	31,125	35.77	8.33	9,266	-11.9	1,076.0	1,725.0
White Tail	30,587	38.22	8.23	9,606	- 2.3	211.6	317.8
Total Annual Benefit				19,394		1,402.6	2,228.5
Annual Benefit/Acre				$17.63		$1.27	$2.03
P.V. Benefit/Acre (infinity)						$25.50	$40.50
P.V. Benefit for 1.1 million ac ($ million)						5.8	9.2
P.V. Benefit for 0.6 million ac ($ million)						5.3	8.5

Source: ALBS, Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Regions which are affected are southern and central.
2. Willingness to pay, including hunting license value.
3. Based on hunter expenditure of $55.68 per day derived from resident hunter survey summarized in W. Phillips, D. De Pape and L. Evanyk, "A Socio-economic Evaluation of the Recreational Use of Fish and Wildlife Resources in Alberta, With Particular Reference to the AOSERP Study Area", AOSERP Report 43, Edmonton, Alberta. Oil Sands Environmental Research Program, December 1978.

acre, based on an infinite stream of hunting expenditures. These expenditures (shown in Table 3.3) form part of the secondary benefit analysis. For maximum expansion, total expenditure foregone would be $9.2 million, while for maximum district expansion it would be $8.5 million.

3.1.4 Direct Net Benefits

Direct benefits and costs are summarized in Table 3.4. These reflect total gains and losses associated with the acreage distribution between expansion and extension as well as infrastructure needs and phasing-in rates. For maximum expansion, the net agriculture value gained was $503 million ($639-$136), while hunting losses were relatively small at $5.8 million. However, infrastructure costs were quite high, totalling $1,647 million, producing a direct societal NPV of -$1,150 million or -$1,009 per acre. The corresponding net agriculture value for maximum district expansion was $411 million. Hunting losses were $5.3 million and infrastructure costs $1,473 million, producing a final direct NPV of -$1,067 million or -$1,859 per acre.

For maximum expansion, the gross B/C ratio was 0.47 ($1,027/$2,177) and the net B/C ratio was 0.36 ($639/$1,789). The corresponding ratios for maximum district expansion were 0.44 ($848/$1,915) and 0.33 ($526/$1,593) respectively. The benefits foregone had no impact on these ratios.

3.1.5 Other Impacts Not Evaluated

There are likely to be both negative and positive impacts from irrigation expansion which are very difficult to measure. The "ALBS: Analysis of Impacts on Other Resources" report contains a full discussion of these impacts, nevertheless, some mention of them should also be made here.

The impact on bird hunting is difficult to ascertain. Although there has been a significant reduction in the number of waterfowl and

TABLE 3.4

DIRECT BENEFITS AND COSTS FOR IRRIGATION EXPANSION

	Present Value[1]				
		Investment Cost			
	Agriculture[2] Gross Margin	On-Farm[3]	Public[4]	Hunting[5] WTP	NPV (To Society)
	(million $)				
Maximum Expansion	639	136	1,647	5.8	-1,150
Maximum Distict Expansion	526	115	1,473	5.3	-1,067

1. PV's relate to phasing-in over 100 years (maximum expansion), or 50 years (district expansion).

2. Assumes a sustained or infinite stream of benefits and costs. Taken from Table 3.1.

3. On-farm costs for sprinklers and dugouts. Taken from Table 3.1.

4. Includes capital costs and maintenance costs to 100 years. Taken from Table 3.2.

5. Willingness to pay, taken from Table 3.3. Benefits foregone phased-out at the same rate as irrigated land phased-in.

upland game birds in southern Alberta over the last twenty to thirty years, it is not known how much of this loss is due to irrigation and how much is due to changes in habitat generally.

Irrigation expansion would likely have a fairly significant positive effect on water-based recreational opportunities, including fishing. Towns would have a more assured water supply, thus, there would be benefits accruing to municipalities.

Increased wind erosion may occur on irrigated cropland as a result of residue being removed as feed and bedding for livestock. There may be some counter-balancing produced by a shift from summerfallowing to continuous cropping under irrigation.

3.2 SECONDARY AND TOTAL BENEFITS - IRRIGATION EXPANSION

The procedure used for measuring secondary and total benefits of agricultural development was described in the Introduction. For benefits resulting from increased agricultural output the "Agriculture Industry" multiplier of 0.870 was used; for the sprinkler irrigation equipment, the "Wholesale and Retail Industry" multiplier of 0.880 was applied and for hunting an average of the "Wholesale and Retail" and the "Food and Accommodations" Industries of 0.839 was adopted. Construction of infrastructure was phased over a long period and there would therefore be a fairly sustained increase in final demand for the construction activity. Thus, the "Construction Industry" multiplier of 0.661 was applied to the infrastructure costs. These multipliers were modified as explained in the Introduction.

Results are presented in Table 3.5. The total benefits gained from increased agricultural production were $872 million made up of $639 million direct value-added and $234 million secondary benefits. In addition, there were total benefits of $1,075 million derived from the on-farm and off-farm investments. Benefits foregone were $6 million for the hunter's direct value lost, plus $8 million for the direct and

TABLE 3.5

SECONDARY AND TOTAL BENEFITS FROM IRRIGATION EXPANSION

Industry or Activity	PV for Total Acreage Gross Value	PV for Total Acreage Gross Margin[1]	Modified[2] Multiplier	PV of Benefits Secondary	PV of Benefits Total
	--- (million $) ---			-- (million $) --	
Maximum Expansion					
Benefits Gained					
Agriculture	1,027	639	0.850	234	872
On-farm Invest.	135	92	0.873	26	118
Off-farm Invest.	1,647	658	0.581	299	957
Total Benefits Gained		1,389		559	1,948
Benefits Foregone[3]					
Hunting WTP	6	6	-	-	6
Hunting EXP	9	6	0.839	2	8
Total Benefits Foregone		12		2	14
Change In Benefits		1,377		557	1,934
Maximum District Expansion					
Benefits Gained					
Agriculture	848	526	0.850	195	721
On-farm Invest.	115	78	0.873	22	101
Off-farm Invest.	1,473	589	0.581	267	856
Total Benefits Gained		1,193		484	1,677
Benefits Foregone[3]					
Hunting WTP	5	5	-	-	5
Hunting EXP	9	6	0.839	2	8
Total Benefits Foregone		11	-	2	13
Change In Benefits		1,182		482	1,664

1. Gross margins derived using the gross margin percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. Hunting benefits derived from Table 3.3. WTP is hunters willingness to pay for the hunting experience, over and above expenditure (EXP).

secondary losses resulting from decreased expenditure on the hunting activity. The change in benefits totalled $1,934 million ($1,698 per acre), made up of $1,377 million direct value-added and $557 million secondary benefits.

Thus, the increase in GDP or the total (direct plus indirect) value-added of $1,934 million (Table 3.5) was greater than the direct net losses of $1,150 million (Table 3.4). The ratio of total benefits (direct and indirect value-added) to total investment (on-farm and off-farm) was 1.08 ($1,934/$1,783). This means that for each $1.00 of investment there was an increase in GDP of $1.08. This implies that with the assumptions and methods used in this study the measured increase in the provincial GDP offsets the private and public investment costs.

It needs to be repeated that some non-quantifiable benefits and costs have not been taken into account. Benefits related to increased or improved recreational facilities were not measured, while possible impacts on water quality through saline seepage were not quantified. In addition, the entire analysis was based on crop production for determining agricultural benefits. Thus, potential livestock value-added benefits were not estimated. This latter assumption was applied to all other alternatives (except range improvement and range conversion). Therefore, the results for any one alternative should not be biased relative to the other alternatives.

4. DRAINAGE

4.1 DIRECT BENEFITS AND COSTS - DRAINAGE

This analysis was based on the "Inventory of Alberta's Drainage Requirements" - Agronomy and Economic Components and on the "ALBS Wildlife Analysis, Economics Component". The former studies were done for five mini-basins and the wildlife analysis was reported on the basis of administrative regions of the Alberta Fish and Wildlife Division. The wildlife regions included in this current study were Peace River, Northeast, Eastern Slopes and a part of the Central Region. The results were extrapolated to five major basins and did not include any area south of the Battle River Basin.

Major adjustments were undertaken to remove inconsistencies between the agronomic and economic studies and to convert the data to a form for analysis consistent with the methodology applied to the other ALBS alternatives.[1] This involved a complete disaggregation of cost and benefit data and the replacement of mitigation costs as the economic value for the impact on wildlife by a benefit foregone value.

The original economic analysis was done for three scenarios: Scenario I (complete drainage); Scenario II (partial drainage); and Scenario III (partial drainage with consolidation). This study examines Scenario II specifically (drainage of temporary wetlands). Some data are provided on Scenario I for comparison.

In the original studies the five mini-basins studied were Teepee, Lalby, Dunvegan, Silver and Shoal. The major basins examined in this study were Peace River, Athabasca, Beaver, North Saskatchewan and Battle. Each mini-basin examined represented specific wetland areas, with characteristic wetland mixes, within the settled area of the province.

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1. Methodology details for the on-farm analysis are presented separately in the "ALBS - Economic and Financial Analysis: Direct Benefits and Costs " study.

The acreage in each major basin, that was represented by different mini-basins was extrapolated on the basis of wetland type, using a linear programming model to determine the best fit (shown in Table 4.1). Beaver and Battle were represented entirely by Shoal and Silver respectively, while, the other three basins were represented by a mix of mini-basin types. Results of the revised economic analysis for each mini-basin were converted to a per acre basis. These values were then scaled up to the extrapolated acreage values. The wildlife benefits foregone were reported by administrative regions. These were converted to a major basin analysis on a pro-rata basis, assuming a linear relationship between acreage and benefit foregone within any given region. Deviation from a linear relationship may produce minor changes in the final results.

4.1.1 Direct Net Benefits

The on-farm economic analysis produced annual equivalent cash flows (AECF's) ranging from $15 per acre in the Beaver River Basin to $57 per acre in the Battle River Basin. Financial analysis showed net annual returns after financing of between $17 and $52 per acre. These results were based on individual sections being drained and developed over three years and costs and returns measured for 30 years. The economic analysis was converted from the 30 year to an infinite time frame and from the individual farm to the entire basin basis, with phasing-in assumed to be over 100 years.

At the mini-basin level, with partial drainage (Scenario II) the direct net benefits ranged from $658 per acre for Shoal Creek to $1,703 per acre for Silver Creek. On-farm investment costs ranged from $139 per acre for Teepee Creek to $821 per acre for Silver Creek. The total acreage examined for each major basin was phased-in over 100 years. Direct net on-farm benefits for each basin are presented in Table 4.2. The on-farm net present value for the entire acreage (2,119 thousand acres) was $410.5 million. This was made up of $182.9 million for the Battle River Basin and $227.6 million for the remaining areas. For complete drainage (Scenario I), the net benefit on-farm was $1,149 million.

TABLE 4.1

ACREAGES REPRESENTED BY EACH MINI-BASIN

Mini Basin	River Basin (acres) Peace	Athabasca	Beaver	N. Sask.	Battle	Totals
<u>Scenario II</u> (Partial Drainage)						
Silver	0	0	0	613,254	836,032	1,449,286
Lalby	0	9,270	0	0	0	9,270
Teepee	64,355	11,546	0	28,094	0	103,995
Dunvegan	49,741	0	0	0	0	49,741
Shoal	166,929	141,808	37,056	161,340	0	507,133
Totals	281,025	162,624	37,056	802,688	836,032	2,119,425

Off-farm infrastructure cost for each basin are presented in Table 4.3. These costs were based on a range of \$550 to \$2,825 per acre for the representative mini-basins (Scenario II). The total off-farm cost was \$373.6 million for the entire acreage. On-farm plus off-farm investment costs totalled \$756 million for partial drainage. The off-farm costs for complete drainage (Scenario I) were between \$331 and \$2,533 per acre and the total cost for the entire acreage was \$997.7 million. The gross B/C ratio on-farm was 1.86 (\$888/\$477) and the net B/C ratio was 2.25 (\$739/\$328) at the farm level. These fell to 1.04 (\$888/\$851) and 1.05 (\$739/\$702), after taking off-farm costs into account.

TABLE 4.2

DIRECT NET ON-FARM BENEFITS FROM DRAINAGE

River Basin	Present Value[1]				
	Total Acres ('000)	Gross Value	Gross Margin	Invest Cost	Net Value
		(million $)			
Scenario II (Partial Drainage)[2]					
Peace	281	97.6	76.2	30.9	45.3
Athabasca	163	54.1	42.2	21.7	20.4
Beaver	37	12.1	9.4	5.5	3.9
N. Saskatchewan	803	342.3	286.5	128.5	158.0
Battle	836	381.5	324.6	141.6	182.9
Total	2,119	887.6	738.9	328.2	410.5

1. Based on infinite streams of benefits and costs and phasing-in over 100 years.

2. With complete drainage (Scenario I) the total acreage was 8,586 thousand and the net value $1,149 million.

TABLE 4.3

PUBLIC INFRASTRUCTURE COSTS FOR OFF-FARM DRAINAGE

River Basin	Total Acres ('000)	P.V.[1] Cost (million $)
Scenario II (Partial Drainage)[2]		
Peace	281	82.5
Athabasca	163	42.2
Beaver	37	10.4
N. Saskatchewan	803	129.0
Battle	836	109.5
Total	2,119	373.6

1. Based on phasing-in over 100 years.

2. The present value of the cost for complete drainage (Scenario I) was $997.7 million.

Annual big game and waterfowl hunting benefits foregone (measured as willingness to pay) resulting from wetland drainage are provided in Table 4.4. Estimated expenditure on these activities are also shown. Trapping benefits foregone are presented in Table 4.5.

The net direct benefits to society resulting from wetland drainage are provided in Table 4.6. The combined loss from hunting and trapping was $14 million, with partial drainage. With complete drainage it was $22 million. With partial drainage (Scenario II) the net benefit to society for the entire acreage was $23 million. After taking benefits foregone into account, the gross and net B/C ratios were 1.03 ($888/$865) and 0.96 ($739/$770) respectively.

4.1.2 Other Impacts Not Evaluated

The measured economic impact on other resource uses was confined to wildlife hunting and trapping benefits that would be lost as a result of wetland drainage. As with other agriculture development alternatives, which would have an impact on wildlife, drainage would affect the non-consumptive use of wildlife as well as recreational fishing.

Impacts on fish were excluded due to lack of biological data. Only recreational hunting and trapping activities were included. In light of this, the estimates provided represent only a small fraction of the actual reduction in benefits if the overall ecosystem effects were taken into account.

Furthermore, real fish and wildlife values may not remain constant. It is therefore not unreasonable to expect that in the future a) demand for certain fish and wildlife related activities could increase due to increased demand and that b) the quality of available resources may shrink thus boosting the future values even higher.[1]

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1. ALBS Wildlife Analysis, Economics Component, 1986.

TABLE 4.4

HUNTING BENEFITS FOREGONE FROM DRAINAGE

River Basin	WTP[1] Annual Benefits Foregone ($/ac)	P.V. Total WTP Foregone ($'000)	Annual Hunting Expenditure ($/ac)	P.V. Total Expenditure[2] Foregone ($'000)	P.V. Expenditure Gross Margin[3] ($'000)
Scenario II (Partial Drainage)					
Peace	20.7	1154.7	18.8	1240.3	650.4
Athabasca	29.2	942.5	43.6	80.7	873.5
Beaver	42.8	314.7	61.1	601.6	279.2
N. Saskatchewan	61.3	9768.7	88.5	17886.4	8751.6
Battle	10.2	1694.5	14.9	326.8	1535.2
Total		13875.1		20135.9	12090.0

Source: ALBS Wildlife Analysis, Economic Component, University of Alberta & Alberta Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife.

1. Willingness to pay, including hunting license value.

2. Based on hunter expenditure of $55.68 per day for big game and $45.46 per day for ducks and waterfowl.

3. Gross margin percentage assumed to be 62.10%.

4. The total WTP foregone for complete drainage (Scenario I) was $21.9 million.

TABLE 4.5

DIRECT TRAPLINE BENEFITS FOREGONE FROM DRAINAGE

River Basin	Annual Fur Value Foregone ($/ac)	P.V. Total Fur Value[1] ($'000)	P.V. Fur Value Gross Margin[2] ($'000)
Scenario II (Partial Drainage)[3]			
Peace	0.419	23.3	18.2
Athabasca	1.678	54.2	42.3
Beaver	1.172	8.6	6.7
N. Saskatchewan	0.908	144.7	113.0
Battle	0.218	36.1	28.2
Total		266.9	208.5

Source: ALBS Wildlife Analysis, Economic Component, University of Alberta and Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife.

1. Benefit foregone phased over 100 years.
2. Gross margin percentage assumed to be 78.11%.
3. The total trapping gross margin benefit foregone for complete drainage (Scenario I) was $265 thousand.

TABLE 4.6

DIRECT NET BENEFITS TO SOCIETY FROM DRAINAGE

River Basin	Agriculture Gross Margin	On-Farm Investment	Off-Farm Investment	Hunter WTP	Trapping	NPV (To Society)
	Present Value ($ million)					
Scenario II (Partial Drainage)[1]						
Peace	76.2	30.9	82.5	1.15	0.02	-38.4
Athabasca	42.2	21.7	42.2	0.94	0.05	-22.8
Beaver	9.4	5.5	10.4	0.31	0.01	-6.8
N.Saskatchewan	286.5	128.5	129.0	9.77	0.14	19.1
Battle	324.6	141.6	109.5	1.69	0.04	71.7
Total	738.9	328.2	373.6	13.86	0.26	22.8

1. The NPV to society for complete drainage (Scenario I) was $129.4 million.

Possible impacts on water quality and other environmental impacts have not been evaluated in this analysis. However, these should be considered when using the economic results reported. Off-farm infrastructure costs were derived from mini-basin costs. No consideration was given to possible impacts on the main rivers. Individual projects would not have a significant effect but drainage of all temporary wetlands in any given basin may require downstream structures to prevent flooding.

4.2 SECONDARY AND TOTAL BENEFITS - DRAINAGE

Gross values for increased agricultural output, on-farm and off-farm expenditures and hunting and trapping benefits foregone were used to derive secondary and total benefits, through multiplier analysis. These are provided in Table 4.7. Scenario II produced a gross value of agricultural output increase of $888 million. This resulted in a direct agriculture value-added of $739 million and a secondary or indirect value-added of $250 million. Investments produced direct and indirect value-added benefits of $281 and $127 million respectively. The wildlife benefits foregone resulted in a direct loss of $26 million and indirect loss of $5 million. Benefits after deducting wildlife losses were $993 million (direct) and $373 million (indirect) giving a total of $1,366 million. Total benefits (direct and indirect value-added) to total investment (on-farm and off-farm) produced a ratio of 1.81 ($1,366/$756). This implies that for every $1.00 invested in drainage there would be a $1.81 increase in GDP at factor cost.

TABLE 4.7

SECONDARY AND TOTAL BENEFITS FROM DRAINAGE

Industry or Activity	PV For Total Acreage Gross Value	Gross Margin[1]	Modified Multiplier[2]	- PV Of Benefits -- Secondary	Total
	-------- (million $)		------	--- (million $)	---
Scenario II (Partial Drainage)					
Benefits Gained					
Agriculture	887.49	738.88	1.11	250.29	989.16
On-Farm Invest.	328.29	131.25	0.58	59.49	190.74
Off-Farm Invest.	373.61	149.37	0.58	67.70	217.07
Total Benefits Gained		1,019.50		377.47	1,396.97
Benefits Foregone					
Hunting WTP[3]	13.88	13.88	--	--	13.88
Hunting EXP	20.14	12.09	0.84	4.80	16.89
Trapping Benefits	0.27	0.21	0.84	0.02	0.23
Total Benefits Foregone		26.17		4.82	30.99
Net Benefits		993.3		372.7	1,366.0

1. Gross margins derived using gross margin percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. No secondary benefits associated with willingness to pay.

5. DEEP PLOWING SOLONETZIC SOILS

5.1 DIRECT NET BENEFITS - DEEP PLOWING SOLONETZIC SOILS

For deep plowing of solonetzic soils, the original economic analysis was based on a ten year project life. Financial analysis produced annual cash flow increases ranging from $17 to $46 per acre depending on soil zone. The comparable economic analysis results were $12 to $41 per acre. The economic results were converted to a fifteen year project period (with a residual value for the last five years). The value derived was then adjusted to an infinite period, assuming recurring deep plowing costs every fifteen years and an infinite stream of benefits. The average NPV for the province, before taking phasing-in into account was $520 per acre (AECF was $26 per acre). With phasing-in 2,220,000 acres over fifty years the average NPV was $190 per acre. For the entire acreage the NPV was $422 million (Table 5.1).

The present value of repeated deep plowing costs was $66 per acre or $146 million for the total acreage phased-in over 50 years. The final NPV to society was equal to the on-farm economic NPV, since there were no off-farm investment costs or other benefits foregone. The final NPV for 2,220,000 acres was $422 million. The gross B/C ratio was 3.89 ($568/$146). This was also the net B/C ratio since there were no increased operating costs (only investment costs). This ratio applied on-farm as well as to society. This ratio compares with ratios of 1.97 to 4.37 (depending on soil zone) derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report.

5.2 SECONDARY AND TOTAL BENEFITS - DEEP PLOWING SOLONETZIC SOILS

Secondary benefits would be derived from the deep plowing activity since each acre would be replowed every fifteen years and the total acreage would be phased-in over fifty years, thus producing an increase in final demand for this service. However, there would be no secondary benefit from the actual increase in agricultural output since this would

TABLE 5.1

DIRECT NET BENEFITS FROM DEEP PLOWING SOLONETZIC SOILS

Soil Zone	Acreage ('000 ac)	Present Value[1] (million $): Gross Value or Gross Margin	Investment Costs	Net Value (On-farm)	Net Value (To Society)
Black	1,170	400	77	323	323
Dark Brown	530	88	35	53	53
Brown	520	80	34	46	46
Total	2,220	568	146	422	422

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. Based on phasing-in over 50 years.

be achieved without any increase in inputs. As shown in Table 5.2, the average weighted PV's of gross revenue and gross margin were equal. The PV's before phasing amounted to $700 per acre and those after phasing $256 per acre. The gross margin for the entire acreage was $568 million.

The wholesale retail multiplier was used to arrive at the secondary benefit of $26 million and a total benefit of $127 million for the deep plowing activity. The total benefit gained was therefore $695 million for the entire acreage. This total was expressed as a ratio to the total investment of $146 million to produce a value of 4.76. This implies that for every $1.00 invested in deep plowing there would be an increase in GDP at factor cost of $4.76 ($695/$146).

TABLE 5.2

SECONDARY AND TOTAL BENEFITS FROM DEEP PLOWING SOLONETZIC SOILS

Industry or Activity	PV for 2.2 M Acres[1] Gross Value	Gross[2] Margin	Modified Mult.[3]	PV for 2.2M Acres Secondary Benefit	Total Benefit
	--- (million $) ---			-- (million $) --	
Benefits Gained					
Agricultural Output	568	568	--	--	568
Deep Plowing Investment	146	101	0.873	26	127
Total Benefit Gained		669		26	695
Change In Benefits		669		26	695

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. PV's based on phasing-in over 50 years.
2. Gross margin values derived using the GM percentages given in Table 1.3.
3. Multipliers derived as in Table 1.3.

6. LIMING ACID SOILS

6.1 DIRECT NET BENEFITS - LIMING ACID SOILS

On-farm analysis produced increased financial cash flows to the producer of between $9 and $11 per acre depending on soil zone. The economic flows, after removing all transfer payments, were $5 to $7 per acre. (Reported in the ALBS - Economic and Financial Analysis: Direct Benefits and Costs.) In converting from the individual farm basis to the large scale, with phasing in 2.51 million acres over 50 years, similar assumptions were used for this alternative as for deep plowing solonetzic soils.

NPV results are given in Table 6.1. With repeated investment in liming every 15 years the NPV was $136 per acre before phasing. After phasing the NPV per acre was $50. For 2,510,000 acres phased-in over fifty years, the NPV was $124 million. The PV of investment for repeated liming was $103 per acre before phasing and $38 per acre with phasing or $95 million for the entire acreage.

As with deep plowing, the NPV to society was equal to the on-farm economic NPV. The final NPV was $124 million for 2,510,000 acres. The B/C ratio for liming acid soils was 2.31 ($219/$95). This applied at the gross and net levels as well as on-farm and to society. The corresponding B/C ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report ranged from 1.68 to 1.94, depending on soil zone.

6.2 SECONDARY AND TOTAL BENEFITS - LIMING ACID SOILS

The PV's of both gross revenue and gross margin for agriculture were $219 million. This represented the direct agricultural value-added. The direct value-added for the liming activity was $52 million and the secondary benefit $23 million. The total benefits from increased agricultural output and the liming activity were $294 million, as shown in Table 6.2. This total produced a ratio of 3.09 to the total investment in liming. This means that for each $1.00 invested in liming there would be an increase in GDP of $3.09 ($294/$95).

TABLE 6.1

DIRECT NET BENEFITS FROM LIMING ACID SOILS

Soil Zone	Acreage ('000 ac)	Present Value (million $): Gross Value or Gross Margin	Investment Costs	Net Value (On-farm)	Net Value (To Society)
Grey Wooded					
Peace	1,030	84	39	45	45
Central	310	25	12	14	14
Black	940	88	35	53	53
Dark Brown	230	21	9	13	13
Total	2,510	219	95	124	124

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. Based on repeated liming every 15 years and an infinite stream of benefits.

2. Based on phasing-in over 50 years.

TABLE 6.2

SECONDARY AND TOTAL BENEFITS FROM LIMING ACID SOILS

Industry or Activity	PV for 2.2 M Acres[1] Gross Value	Gross Margin[2]	Modified Mult.[3]	PV for 2.2M Acres Secondary	Total Benefit
	--- (million $) ---			-- (million $) --	
Benefits Gained					
Agricultural Output	219	219	--	--	219
Liming	95	52	0.845	23	75
Total Benefit Gained		271		23	294
Change In Benefits		271		23	294

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. PV's based on phasing-in over 50 years.
2. Gross margin values derived using the GM percentages given in Table 1.3.
3. Multipliers derived as in Table 1.3.

7. SUMMERFALLOW REDUCTION

7.1 DIRECT NET BENEFITS - SUMMERFALLOW REDUCTION

The results of financial analysis showed changes in the annual cash flow (AECF) to farmers ranging from -$2 in the Brown soil zone to $4 to $12 per acre in the other soil zones. The economic results (including all transfer payments) were between -$2 and $11 per acre. As in other alternatives the results of the original on-farm economic analysis were converted to an infinite basis, assuming continued management as described for the original nine year project life. The results of the on-farm analysis showed summerfallow reduction in the Brown soil zone to be uneconomical, therefore, this soil zone was not subjected to further analysis. The weighted average NPV for the other soil zones was $140 per acre, before taking phasing-in into account. This value was reduced to $51 per acre with phasing-in 930,000 acres over fifty years, producing a total value of $48 million (Table 7.1).

The net benefits to society were equal to the on-farm economic benefits since there were no quantified benefits foregone nor any off-farm costs. Thus the total net benefit for reducing summerfallow on 930,000 acres was $48 million. The gross B/C ratio for summerfallow reduction was 1.30 ($208/$160) at both the farm and societal levels. A net B/C ratio would approach infinity since there were no investment costs. The ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report ranged between 1.03 and 1.60 (excluding the Brown soil zone).

7.1.1 Other Impacts Not Evaluated

This alternative examined a simple reduction in summerfallow acreage, moving from a less intensive to a more intensive rotation. No specific conservation practices such as reduced tillage were taken into account.

However, a significant reduction in summerfallowed acreage would reduce the amount of soil degradation due to wind erosion across the province. Although it is generally uneconomical for farmers in the

TABLE 7.1

DIRECT ON-FARM AND SOCIETAL BENEFITS FROM SUMMERFALLOW REDUCTION

Soil Zone	Acreage ('000 ac)	Gross Value	Gross Margin or Net	NPV (To Society)
		Present Value (million $)		
Grey Wooded				
Peace	180	25	4	4
Central	30	4	1	1
Black	260	48	14	14
Dark Brown	460	130	30	30
Total	930	208	48	48

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. Based on summerfallow acreage reduced and held constant.

2. Based on phasing-in over 50 years.

Brown soil zone to reduce summerfallow, that is the area with the highest percentage of summerfallowed land and the area most subject to wind erosion. The introduction of conservation measures would present a different economic picture and may reverse the findings for the Brown soil zone. Summerfallow reduction would also have a positive impact on dryland salinization, reducing the rate of increase, if not producing a reversal of the process.

7.2 SECONDARY AND TOTAL BENEFITS - SUMMERFALLOW REDUCTION

The average gross value of output from summerfallow reduction with phasing-in was $223 per acre. The gross margin of $140 per acre was equal to the NPV since there were no capital investment costs. The gross margin values varied widely between soil zones from $1 to $30 million. The total benefits (including secondary benefits) from summerfallow reduction varied from $1 to $40 million, with a total of $64 million for all soil zones (Table 7.2). The ratio of total benefits to the investment cost would approach infinity, since there were no investment costs.

Secondary benefits accounted for $16 million while the direct benefit or gross margin accounted for $48 million for the entire 930,000 acres being considered. There were no significant on-farm investments in machinery or construction, therefore there were no additional secondary benefits resulting from increased final demands in the wholesale and retail or construction industries.

TABLE 7.2

SECONDARY AND TOTAL BENEFITS FROM SUMMERFALLOW REDUCTION

Industry or Activity	PV for .93M Acres Gross Value --- (million $) ---	Gross Margin[1]	Modified Mult.[2]	PV for .93M Acres Secondary Benefit -- (million $) --	Total
Benefits Gained					
Agricultural Output	208	48	0.309	16	64
On Farm Investment	0	0	--	0	0
Total Benefit Gained		48		16	64
Change In Benefits		48		16	64

Source: ALBS, Direct Benefits and Costs new computer runs (1985).

1. Gross margin values derived using the GM percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

8. FLOOD CONTROL

8.1 DIRECT BENEFITS AND COSTS - FLOOD CONTROL

Agricultural production occurs on many of the flood plains of Alberta's streams, rivers and lakes. However, producers farming this land risk crop damage due to unpredictable and uncontrollable flooding. Dykes, reservoirs and channel alignments have been used throughout Alberta to alleviate flooding. Approximately 65,000 acres of flood prone land have been protected to date and a further 100,000 acres have been identified for possible future protection. Flood affected lands produce less than average crop yields. Flood protection returns these lands to regional average yields.

This alternative was not subjected to the same level of analysis as the others because of limited information and the relatively small acreage affected. A report by the Planning Division of Alberta Environment entitled "An Overview of Flood Control Measures to Enhance Agricultural Productivity in Alberta" provided a small amount of information on the benefits and costs of flood control in Alberta.

8.1.1 Agricultural Benefits

In years of high spring runoff, complaints of flooding have been received on 175,000 to 200,000 acres. The "Agricultural Land Base Study: Agricultural Inventory" report stated that there are approximately 100,000 acres of flood prone land in areas where persistent flooding has occurred. Both sources state that the problem is located in central and northern Alberta. These acreages give an estimate of the potential for agricultural benefits from flood control.

The Alberta Environment report stated that in 1974, the year in which the most extensive flood damage occurred, the value of these damages may have been $7.5 to $10 million. In some cases, seeding was delayed and in others, no crop could be grown. The ALBS: Agricultural Inventory report focused on changes in cropping patterns and in crop yields which could be expected as a result of flood control. It

estimated the increase in average annual crop gross returns could be $1.4 million. It should be recognized that spring flooding of hay producing land can be beneficial and that through the implementation of flood control projects, this benefit may be lost.

8.1.2 Investment Costs

Regarding the public investment costs for flood control projects, the Alberta Environment report gave a range of costs for channelization projects from $45 to $209 per benefiting acre. The report quoted the case of dykes on the Pembina River which, at current prices would cost approximately $900,000. In 1980, during a 1:15 flood event, these dykes apparently protected an area of 13,000 acres from severe flooding, at a cost of approximately $70 per acre. The dykes are currently in disrepair and rebuilding to acceptable standards would entail an estimated cost of $3 million and an annual maintenance cost of $150,000. To be economically feasible the average annual benefits would need to be $345,000, whereas, the average annual flood damage is estimated to be only $100,000 to $200,000.

Proposed dykes on the Vermilion River are estimated to cost $3.2 million and average flood damages appear to be $50,000 to $60,000. On the Whitemud River in the Peace River region, proposed dykes would cost $2.25 million, annual maintenance costs would be $65,000 and average annual benefits are estimated to be $78,000.

8.1.3 Direct Net Benefits and Secondary Benefits

From the point of view of direct benefits, these projects do not appear to be warranted, nor do reservoirs such as the Paddle River Dam, which the Alberta Environment report indicates has a benefit cost ratio of 0.42:1. However, if secondary economic benefits resulting from increased agricultural production and construction activity are taken into account, the social economic analysis may show such projects to be feasible.

With the limited information available on societal benefits and costs from flood control in Alberta, no conclusions on economic feasibility can be drawn here. Most projects involve high public investment requirements and do not appear to be warranted on the basis of direct net benefits alone. However, if secondary economic benefits are also counted in the societal analysis, this could be reversed.

9. RANGELAND IMPROVEMENT

9.1 DIRECT BENEFITS AND COSTS - RANGELAND IMPROVEMENT

The ALBS examined rangeland improvement on both prairie and woodland range. The direct on-farm analysis showed woodland range improvement to be uneconomical under the assumptions used. Further analysis is, therefore, restricted to prairie range improvement. The financial analysis produced increased cash flows (AECF's) to the producer of between $1 and $21 per acre for prairie range improvement (woodland range values were -$11 to -$21 per acre). The economic values (excluding all transfer payments) were $0 to $24 per acre for prairie range improvement and -$7 to -$9 for woodland range improvement.

In the "ALBS Agricultural Inventory" report a total acreage of 1,040,000 acres of prairie range was identified as having potential for improvement. Large acreages of CLI Class 5 land with severe natural limitations have been ommitted. However, 760,000 acres were located in the Brown soil zone where there may be potential soil conservation problems associated with land breaking. This study did not examine that specific problem but it must be taken into consideration when evaluating total benefits and costs.

9.1.1 Direct Net Benefits

The direct on-farm analysis results were converted from a finite 25 year project life to a situation reflecting sustained benefits and costs. The total acreage examined in each soil zone was phased in over 50 years. As expected, results were best in the Black soil zone with an NPV after phasing of $172 per acre and a total of $26 million for 150,000 acres. The weighted average for the three soil zones was $40 per acre and the total value was $41 million (Table 9.1). On-farm investment costs totalled $40 million for 1,040,000 acres. The gross B/C ratio derived was 1.50 ($123/$82) and the net B/C ratio 2.03 ($81/$40). These were applied at the farm level. They fell to 1.05 ($123/$117) and 1.08

TABLE 9.1

DIRECT NET ON-FARM BENEFITS FROM PRAIRIE RANGELAND IMPROVEMENT

Soil Zone	Acreage	Present Value[1]			
		Gross Value	Gross Margin	Investment Cost	Net Value (On-farm)
	('000 ac)	(million $)			
Black	150	47	32	6	26
Dark Brown	130	28	19	5	14
Brown	760	48	30	29	1
Total	1,040	123	81	40	41

Source: ALBS, Direct Benefits and Costs new computer run (1985).

1. Based on infinite streams of benefits and costs and phasing-in over 50 years.

($81/$75) respectively when benefits foregone were included. The gross B/C ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report were between 1.01 and 1.25, depending on soil zone.

Annual big game hunting benefits foregone (measured as willingness to pay), from the total conversion of 1,040,000 acres of prairie range to tame pasture, were estimated at $5,809,100 (Table 9.2). This was converted to a PV of $111.71 per acre. When phasing was taken into account the PV for the total acreage was $42 million. Annual hunting expenditure was estimated at $9,874,000 based on $55.68 per day. This was equivalent to $189.88 per acre with an infinite stream of hunting benefits and costs. Total expenditure with phasing was $72 million.

Direct benefits to society from prairie range improvement for three soil zones are given in Table 9.3. Net on-farm benefits and benefits to society were $41 million. These were $1 million below the hunting benefits foregone, which totalled $42 million.

9.1.2 Other Impacts Not Evaluated

Although no economic impact on upland game birds and waterfowl has been included here, the ALBS: Impact on Other Resources report indicated that there would be a significant negative impact on these species that breed within the province. As a result, there would be a negative impact on bird hunting.

Increases in cattle population may also increase the phosphorus concentration in those water basins that have higher livestock carrying capacities as a result of rangeland improvement.

9.2 SECONDARY AND TOTAL BENEFITS - PRAIRIE RANGE IMPROVEMENT

Gross values for increased agricultural output, investment expenditures and hunting benefits foregone were used to derive secondary and total benefits, through multiplier analysis. The gross value of

TABLE 9.2

HUNTING BENEFITS FOREGONE FROM PRAIRIE RANGE IMPROVEMENT

Type	# of Hunters	WTP[1]/Day /Hunter	# of Days /Hunter	Total Benefits ($ '000)	% Change Benefits	WTP Benefits Foregone ($ '000)	Expenditure[2] Foregone ($ '000)
Moose	45,419	32.38	9.37	13,522.3	9.10	1,230.0	2,156.1
Elk	31,715	31.88	9.27	9,254.4	15.55	1,439.2	2,545.4
White Tail	51,476	39.11	8.01	16,105.5	5.47	881.1	1,256.5
Mule Deer	31,125	32.64	9.14	15,563.5	10.89	1,694.4	2,929.1
Antelope	3,426	34.45	3.00	522.4	21.00	109.7	177.3
Black Bear	8,926	31.66	9.35	2,609.3	17.43	454.7	809.5
Total Annual Benefit						5,809.1	9,874.0
Annual Benefit/Acre						$ 5.59	$ 9.49
P.V. Benefit/Acre (infinity)						$111.71	$189.88
P.V. Benefit for 1.04 M Acres ($/million)						42.4	72.1

Source: ALBS: Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Willingness to pay, including hunting license value.

2. Based on hunter expenditure of $55.68 per day.

TABLE 9.3

DIRECT NET BENEFITS TO SOCIETY FROM PRAIRIE RANGELAND IMPROVEMENT

Present Value[1]			
Agriculture Gross Margin	On-Farm Investment	Hunting[2] WTP	NPV (To society)
(million $)			
81	40	42	-1

Source: Derived from Tables 9.1 and 9.2.

1. All PV's based on infinite streams of benefits and costs and phasing over 50 years.

2. Willingness to pay, taken from Table 9.2.

agricultural output increase was $123 million and the gross margin $81 million. Secondary and total benefits gained and foregone are given in Table 9.4. Total benefits gained were $144 million of which $36 million were secondary benefits. Benefits foregone totalled $102 million of which $15 million were secondary benefits. The change in benefits after deducting benefits foregone were $42 million. Secondary benefits comprised $21 million. The ratio of total benefits to investment costs was 1.05 ($42/$40). This implies that for every $1.00 of investment there would be an increase in GDP of $1.05.

TABLE 9.4

SECONDARY AND TOTAL BENEFITS FROM PRAIRIE RANGELAND IMPROVEMENT

Industry or Activity	PV for 1.04M Acres Gross Value	PV for 1.04M Acres Gross Margin[1]	Modified Mult.[2]	PV for 1.04M Acres Secondary Benefit	PV for 1.04M Acres Total Benefit
	--- (million $) ---			-- (million $) --	
Benefits Gained					
Agriculture	123	81	0.890	28	109
On-Farm Investment	40	27	0.873	8	35
Total Benefits Gained		108		36	144
Benefits Foregone[3]					
Hunting WTP	42	42	--	--	42
Hunting EXP	72	45	0.839	15	60
Total Benefits Foregone		87		15	102
Change In Benefits		21		21	42

Source: ALBS, Direct Benefits and Costs; new computer runs (1985).

1. Gross margin values derived using the GM percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. There are no operating costs associated with WTP, therefore, there are no secondary benefits.

10. RANGELAND CONVERSION

10.1 DIRECT BENEFITS AND COSTS - RANGELAND CONVERSION

The direct on-farm analysis produced increased annual cash flows (AECF's) to the producer of $28 to $41 per acre. The economic analysis (excluding all transfer payments) showed cash flow increased of $29 to $43 per acre. These latter results were converted from the individual farm and a 10 year period to the large scale and an infinite basis as for other alternatives. Net present value results for rangeland conversion are given in Table 10.1.

With the assumptions of infinite benefits and costs and a phasing-in period of 50 years, the net benefit for 3.53 million acres was $307 million. This was equivalent to an NPV of $87 per acre. The on-farm investment cost associated with this activity was $24 per acre or a total of $85 million. Big game hunting and trapping benefits foregone are shown in Tables 10.2 and 10.3. The total annual losses would be $5,238,000 and $91,914 respectively. These values converted to PV's of $29.68 and $0.52 per acre. With phasing over 50 years, hunting and trapping benefits totalled $39 million. Net societal benefits are provided in Table 10.4. These totalled $268 million for the entire acreage or the equivalent of $76 per acre (after phasing).

The gross B/C ratio was 1.19 ($1,892/$1,585) and the net B/C ratio 4.61 ($392/$85) at the on-farm level. With benefits foregone included, these fell to 1.17 ($1,892/$1,624) and 3.16 ($392/$124) respectively. Gross B/C ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report ranged from 1.82 to 2.06.

10.1.1 Other Impacts Not Evaluated

Although the ALBS: Impacts on Other Resources report contains a detailed discussion of a number of the impacts of range conversion, some merit recognition here as well, because of their importance. Thirty-seven mammal species, including sixteen subject to licensed consumptive

TABLE 10.1

DIRECT NET BENEFITS FROM RANGELAND CONVERSION

Soil Zone	Acreage ('000 ac)	Present Value[1] Gross Value (million $)	Gross Margin	Investment Cost	Net Value
Black	640	435	119	26	94
Dark Brown	890	572	110	25	85
Brown	2,000	885	163	34	128
Total	3,530	1,892	392	85	307

Source: ALBS, Direct Benefits and Costs; new computer run (1985).

1. Based on sustained benefits and costs and phasing-in over 50 years.

TABLE 10.2

HUNTING BENEFITS FOREGONE FROM PRAIRIE RANGE CONVERSION

Type	# of Hunters	WTP[1]/Day /Hunter	# of Days /Hunter	Total Benefits ($ '000)	% Change Benefits	WTP Benefits Foregone ($ '000)	Expenditure[2] Foregone ($ '000)
Mule Deer	56,377	33.04	9.05	16,624	-14.48	2,407	4,113
White Tail	70,127	36.45	8.62	21,698	-12.47	2,706	4,199
Antelope	5,055	34.45	3.00	522	-24.00	125	203
Total Annual Benefit						5,238	8,515
Annual Benefit/Acre						$ 1.48	$ 2.41
P.V. Benefit/Acre (infinity)						$29.68	$48.24
P.V. Benefit for 3.530 M.Acres						38.2	62.2

Source: ALBS Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Willingness to pay, including hunting license value.
2. Based on hunter expenditure of $55.68 per day.

TABLE 10.3

TRAPPING BENEFITS FOREGONE FROM PRAIRIE RANGE CONVERSION

Trapping Region	Total # of Trappers	Trap Revenues ($)	% of Traps Lost	Lost Fur Revenue ($)
Central	342	104,944	28	29,384
Northeast	792	289,564	18	52,122
Peace	1,454	479,683	2	9,594
Eastern	188	81,436	1	814
Total Annual Benefit		955,627	9.62	91,914
Annual Benefit/Acre				$0.03
P.V. Benefit/Acre				$0.52
P.V. Benefit for 3.53 M Acres				0.67

Source: ALBS Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

TABLE 10.4

DIRECT SOCIETAL BENEFITS AND COSTS FOR PRAIRIE RANGE CONVERSION

Present Value[1] (million $)				
Agriculture Gross Margin	On-Farm Investment	Hunting	Trapping	NPV (To Society)
392	85	38	1	268

Source: Derived from Tables 10.1, 10.2 and 10.3.

1. PV's relate to phasing-in over 50 years and assumes sustained benefits and costs.

use, would be negatively affected through range conversion. Additionally, breeding bird species (including both upland game birds and waterfowl) would be reduced. Although 110,000 AUM's of grazing would be displaced, in terms of numbers this is not considered to be a significant loss.

The estimate of total CLI Class 1-4 rangelands were reduced to account for areas most likely to erode if broken for cultivation. However, the potential for erosion, from both wind and water, is likely to increase unless mitigative action is taken prior to and at the time of conversion.

10.2 SECONDARY AND TOTAL BENEFITS - RANGELAND CONVERSION

Gross revenues from rangeland conversion averaged $536 per acre and the gross margin was $111 per acre. Through the use of multiplier analysis these produced total benefits of $149 per acre of which $39 made up the secondary benefit. On-farm investment produced a further $21 per acre of total benefits (with $5 being secondary benefits). The total benefits gained were $602 million, made up of $528 million from increased agricultural output and $74 million from on-farm investment (Table 10.5).

Multiplier analysis produced total benefits foregone of $91 million. These benefits foregone included the direct hunters' willingness to pay totalling $38 million and the expenditure benefits of $52 million for the entire acreage. Trapping benefits totalled $0.6 million. After deducting measurable benefits foregone the secondary benefits from rangeland conversion were $139 million for 3,530,000 acres. Total benefits were $511 million of which the direct value-added was $372 million.

Expressed as a ratio, total benefits to total investment was 6.01 ($511/$85). This implies that for each $1.00 of investment in woodland conversion there would be an increase in GDP of $6.01.

TABLE 10.5

SECONDARY AND TOTAL BENEFITS FROM CONVERSION OF RANGELAND TO CROPLAND

Industry or Activity	PV for 3.53M Acres Gross Value	Gross Margin[1]	Modified Mult.[2]	PV for 3.53M Acres Secondary	Total Benefit
	--- (million $) ---			-- (million $) --	
Benefits Gained					
Agriculture	1,892	392	0.279	136	528
On-Farm Investment	85	58	0.873	16	74
Total Benefits Gained		450		152	602
Benefits Foregone					
Hunting WTP[3]	38	38	--	--	38
Hunting EXP[4]	62	39	0.839	13	52
Trapping	0.7	0.5	0.843	0.04	0.6
Total Benefits Foregone		78		13	91
Change In Benefits		372		139	511

Source: ALBS, Direct Benefits and Costs; new computer runs (1985).

1. Gross margin values derived using the GM percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. There are no operating costs associated with WTP (willingness to pay), therefore, there are no secondary benefits.

4. Secondary and direct benefits associated with expenditure on hunting.

11. WOODLAND CONVERSION

11.1 DIRECT BENEFITS AND COSTS - WOODLAND CONVERSION

The total woodland area suitable for conversion to cropland was estimated at 7.07 million acres. This is equivalent to approximately 120 acres per farmer (based on 1981 census data) and corresponds quite closely with the values of 80 acres and 160 acres per farm used in the on-farm analysis. Because of the large acreage involved and the corresponding resource requirements, conversion was assumed to be spread over 50 years. To achieve conversion within 50 years would require adoption by over 1,000 farmers per year.

The original on-farm financial analysis showed woodland conversion to be feasible, with increased annual cash flows (AECF) of $26 and $57 per acre for Gray and Black soil zones respectively. The exclusion of all transfer payments produced economic AECF's of $22 and $50 per acre respectively. Again, the assumptions of infinite costs and benefits were applied to convert to the large scale with phasing over 50 years.

Results for on-farm analysis for woodland conversion are provided by soil zone in Table 11.1. The gross margin produced averaged $932 per acre, before phasing. After phasing the value was $340 per acre or $2,406 million for the entire acreage. The PV of the cost of converting woodland to cropland was $214 per acre, before phasing was taken into account. With phasing this value was $78 per acre or $553 million for the entire acreage. The NPV of the conversion was $262 per acre. For the 7.07 million acres considered, the NPV was $1,853 million.

Annual hunting and trapping benefits that would be foregone by the conversion of 7,070,000 acres of woodland are provided in Tables 11.2 and 11.3. These amounted to $8,509,906 and $373,516 respectively. As with other activities these were phased over 50 years. The NPV's of hunting and trapping benefits foregone were $24.07 and $1.06 per acre respectively. With phasing, the total benefits foregone were $62.1 million for hunting and $2.7 million for trapping.

TABLE 11.1

DIRECT NET BENEFITS FROM WOODLAND CONVERSION

Soil Zone	Acreage ('000 ac)	Net Present Value[1] (million $) Gross Value	Gross Margin	Investment Cost	Net Value (on-farm)
Gray Wooded					
Peace	3,140	2,008	1,038	167	871
Central	1,800	1,848	870	246	624
Black	2,130	1,059	499	141	358
Total	7,070	4,915	2,406	553	1,853

Source: ALBS, Direct Benefits and Costs; new computer run (1985).

1. Based on phasing-in over 50 years.

TABLE 11.2

HUNTING BENEFITS FOREGONE FROM WOODLAND CONVERSION

Type	# of Hunters	WTP[1]/Day /Hunter	# of Days /Hunter	Total Benefits ($ '000)	% Change Benefits	WTP Benefits Foregone ($ '000)	Expenditure[2] Foregone ($ '000)
Moose	62,692	35.03	8.88	19,050	10.47	1,995	3,249
White Tail	64,905	37.09	8.58	20,300	24.66	5,005	7,648
Mule Deer	40,521	33.16	9.23	12,144	8.94	1,085	1,860
Black Bear	11,605	36.04	8.77	3,581	11.85	424	671
Total Annual Benefit						8,510	13,428
Annual Benefit/Acre						$ 1.20	$ 1.90
P.V. Benefit/Acre (infinity)						$24.07	$37.99
P.V. Benefit for 7.07 M. Acres ($/million)						62.1	98.1

Source: ALBS Wildlife Analysis, Economics Component, University of Alberta and Alberta Fish and Wildlife Division.

1. Willingness to pay, including hunting licence value.

2. Based on hunter expenditure of $55.68 per day.

TABLE 11.3

TRAPPING BENEFITS FOREGONE FROM WOODLAND CONVERSION

Trapping Region	---------- Resident Trapping ----------- Total Trappers	Trap Revenues	% of Traps Lost	Lost Fur $	Registered[1] # of Areas	Lost Fur $	Total Lost Fur $
Central	792	289,564	- 10.00	28,956	5	1,903	30,859
Northeast	1,454	479,683	- 20.00	95,937	9	1,336	97,273
Peace	494	170,078	- 44.00	74,834	162	131,250	206,084
Eastern Sl.	188	81,436	- 21.00	17,102	53	22,198	39,300
Total Annual Benefit				216,829	229	156,687	373,516
Annual Benefit/Acre							$ 0.05
P.V. Benefit/Acre (infinity)							$ 1.06
P.V. Benefit for 7.07 M Acres ($ million)							2.7

Source: ALBS Wildlife Analysis, Economics Component, Univesity of Alberta and Alberta Fish and Wildlife Division.

1. Derived as described for Expansion.

The direct benefits gained and foregone are summarized in Table 11.4. The direct farm benefits gained were $1,853 million and those foregone were equal to $65 million. The net benefits to society were $1,788 million. At the on-farm level the gross B/C ratio was 1.61 ($4,915/$3,062) and the net B/C ratio was 4.35 ($2,406/$553). These fell to 1.57 ($4,915/$3,127) and 3.89 ($2,406/$618) respectively when benefits foregone were included. Gross B/C ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs Analysis report ranged from 1.39 to 1.68 depending on soil zone.

11.1.1 Other Impacts Not Evaluated

It must be emphasized that only the impacts on hunting and trapping were quantified in this analysis. Other potential impacts on soil and water conservation (erosion and water quality) were not taken into account. These could have significant consequences through the removal of shelter belts. There could also be an impact on livestock production, which was not measured in this analysis. The actual loss of a potential timber production resource was not evaluated. This resource could have a substantial productive value in the future.

Estimates for other impacts given in the ALBS Analysis of Impacts on Other Resources are repeated here for emphasis. Forty five mammal species, of which twenty five are used for licensed consumptive use, would be negatively affected by woodland range conversion. A small percentage of trapline areas would also be affected, resulting in 19 percent of the province's trappers being put out of business.

Although difficult to quantify, there is likely to be a fairly substantial decline in non-consumptive wildlife benefits as a result of woodland conversions; particularly in the Northeast and Peace regions. As with an expansion of agricultural lands in the Green Area, the conversion of woodlands would also increase problems of erosion and water quality degradation.

11.2 SECONDARY AND TOTAL BENEFITS - WOODLAND CONVERSION

The procedure used for other alternatives and described in the

TABLE 11.4

DIRECT SOCIETAL BENEFITS AND COSTS FOR WOODLAND CONVERSION

Present Value[1]				
Agriculture Gross Margin	On-Farm Investment	Hunting (million $)	Trapping	NPV (To Society)
2,406	553	62	3	1,788

Source: Derived from Tables 11.1, 11.2 and 11.3.

1. PV's relate to phasing-in rate over 50 years and assumes sustained benefits and costs.

Introduction was adopted in estimating secondary benefits of woodland conversion. Gross output and gross values were used to derive the total and secondary impact of increased agricultural production, given in Table 11.5. Secondary benefits from increased agricultural production were \$836 million and total benefits \$3,242 million. In addition, secondary benefits resulting from the activities of clearing and developing the land were \$101 million and total benefits \$322 million. Secondary benefits foregone, related to hunting and trapping were \$22 million and total benefits foregone were \$147 million. The secondary benefits after deducting those foregone from hunting and trapping were \$915 million. The corresponding total benefits were \$3,417 million.

The ratio of total benefits to investment costs was 6.17 (\$3,417/\$553). This means that for every \$1.00 of investment in woodland conversion there would be an increase in GDP of \$6.17.

TABLE 11.5

SECONDARY AND TOTAL BENEFITS FROM WOODLAND CONVERSION

Industry or Activity	PV for 7.07M Acres Gross Value	PV for 7.07M Acres Gross Margin[1]	Modified Mult.[2]	PV for 7.07M Acres Secondary Benefit	PV for 7.07M Acres Total Benefit
	--- (million $) ---			-- (million $) --	
Benefits Gained					
Agriculture	4,915	2,406	0.660	836	3,242
On-Farm Investment	553	221	0.581	101	322
Total Benefits Gained		2,627		937	3,564
Benefits Foregone					
Hunting WTP[3]	62	62	--	--	62
Hunting EXP[4]	98	61	0.839	21	82
Trapping	3	2	0.843	1	3
Total Benefits Foregone		125		22	147
Change In Benefits		2,502		915	3,417

Source: ALBS, Direct Benefits and Costs; new computer runs (1985).

1. Gross margin values derived using the GM percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

3. There are no operating costs associated with WTP (willingness to pay) therefore, there are no secondary benefits.

4. Secondary and direct benefits associated with expenditure on hunting.

12. SALINE RECLAMATION

12.1 DIRECT BENEFITS AND COSTS - SALINE RECLAMATION

On-farm values for dryland saline reclamation were based on data for Warner County. These were applied to both the Brown and Dark Brown soil zones. No analysis was done for the Black and Gray soils because of a lack of data. Values for irrigated saline reclamation were based on estimates for three irrigation districts and three levels of salinity. Due to a lack of additional data these values were applied to all irrigation climatic zones. Variations may exist between zones but could not be quantified in this analysis. Reclamation was assumed to be phased over 50 years for both dryland and irrigated conditions.

Financial analysis produced annual cash flow (AECF) increases of $19 per acre for dryland conditions and $52 per acre for irrigated conditions. The respective economic AECF increases were $2 and $46 per acre (excluding all transfer payments). Results were extrapolated to large scale reclamation assuming infinite benefits and costs.

Results from the on-farm analysis are presented in Table 12.1. The gross margin values were $71 million and $147 million for dryland and irrigated reclamation respectively. On-farm investment costs in reclamation were $27 million for dryland and $47 million for irrigated lands. The NPV for dryland reclamation was $45 million (1,310,000 acres) and for irrigated reclamation $100 million (250,000 acres). There were no off-farm investment costs measured and no benefits foregone, hence the final economic NPV's to society were equal to the on-farm economic NPV's. These totalled $145 million.

For dryland reclamation, the gross B/C ratio was 1.29 ($194/$150) and the net B/C ratio was 2.63 ($71/$27). These applied at the farm and societal levels. For irrigated reclamation the gross and net B/C ratios were 1.24 ($513/$413) and 3.13 ($147/$47) respectively. The gross B/C ratios derived in the ALBS Economic and Financial Analysis: Direct Benefits and Costs report were 1.15 for dryland saline reclamation and between 1.16 and 1.26 for irrigated saline reclamation.

TABLE 12.1

DIRECT NET BENEFITS AND DIRECT SOCIETAL BENEFITS FROM SALINE RECLAMATION

Soil Zone or Irrigation Climatic Zone	Acreage ('000 ac)	Present Value[3]: Gross Value	Gross Margin	Investment Cost	Net Value[4]
		(million $)			
Dryland[1]					
Dark Brown	690	102	38	14	24
Brown	620	92	34	13	21
Total/Average	1,310	194	71	27	45
Irrigated[2]					
A1	50	103	30	9	20
A2	140	287	82	27	56
B	10	20	6	2	4
C	50	103	30	9	20
Total	250	513	147	47	100
Total (Dryland & Irrigated)	1,560	707	218	74	145

Source: ALBS 1985 computer runs.

1. PV's based on estimates prepared from Warner County data.
2. PV's based on average for three irrigation districts and three levels of salinity.
3. Based on phasing-in over 50 years.
4. Value to society equal value on-farm.

12.1.1 Other Impacts Not Evaluated

In the case of irrigated saline reclamation there would be some off-farm drainage costs and there may be an impact on fish and wildlife through the drainage of sloughs. However, these have not been measured. Other non measured impacts would generally be positive, resulting from the arrest of salinization and a slow down in the rate of land going out of productive use due to salinity.

12.2 SECONDARY AND TOTAL BENEFITS - SALINE RECLAMATION

There would be secondary benefits derived from both the increased agricultural output and the investment needed to bring about reclamation. As for other alternatives the "Agriculture Industry" multiplier of 0.870 was used for increased agricultural output. This was also applied to the reclamation investment for dryland salinity, since most of the investment inputs were agricultural. The "Construction Industry" multiplier of 0.661 was used for measuring secondary benefits from drainage of irrigated saline soils. Results are presented in Table 12.2. Secondary benefits from increased agricultural output were $25 million and $51 million for dryland and irrigated land respectively and total benefits were $96 million and $198 million. Additional secondary benefits of $15 million were derived from the reclamation investment and additional total benefits of $49 million. The combined secondary benefits were $91 million and the combined total benefits $343 million.

The ratio of total benefits from dryland saline reclamation to the investment cost was 4.37 ($118/$27) and that for irrigated saline reclamation 4.79 ($225/$47). This means that for every $1.00 invested in dryland reclamation there would be an increase in GDP of $4.37 and for every $1.00 invested in irrigated reclamation there would be a $4.79 increase in GDP.

TABLE 12.2

SECONDARY AND TOTAL BENEFITS FROM SALINE RECLAMATION

Industry or Activity	PV for 1.04M Acres Gross Value --- (million $) ---	Gross Margin[1]	Modified Mult.[2]	PV for 1.04M Acres Secondary Benefit -- (million $) --	Total
Dryland Benefits Gained					
Agric. Output	194	71	0.494	25	96
On-Farm Invest.	27	15	0.803	7	22
Total Dryland		86		32	118
Irrigated Benefits Gained					
Agric. Output	512	147	0.387	51	198
On-Farm Investment	47	19	0.581	8	27
Total Irrigated		166		59	225
Total Benefits Gained					
Dryland		86		32	118
Irrigated		166		59	225
Total		252		91	343

Source: ALBS, Direct Benefits and Costs; new computer runs (1985).

1. Gross margin values derived using the GM percentages given in Table 1.3.

2. Multipliers derived as in Table 1.3.

13. SUMMARY AND CONCLUSIONS

13.1 METHODOLOGY

Measurable and quantifiable economic impacts produced by each of eleven agricultural development alternatives were examined in this study. Benefits and costs evaluated were: the direct on-farm benefits and costs (including on-farm capital investment); off-farm or public infrastructure costs; and direct benefits foregone. Analysis was economic, not financial, therefore, transfer payments (including subsidies, taxes, interest payments and grants) were not evaluated. Secondary benefits gained or lost were measured through multiplier analysis.

The base data for both agriculture and other sectors, have a number of underlying assumptions related to yields, prices, costs and markets. It was assumed that the cost/price relationships and physical relationships would remain constant for the project lives considered. It was also assumed that markets would exist for the increased production resulting from agricultural development, and there would be no impact on either input or product prices. This assumption also applied to the estimates for timber production as it relates to existing output and some increased output from potentially productive forest lands.

The net benefits measured for agriculture represented returns to land, labor, management and existing investment. Values were based on the best existing physical and biological data available. However, there were gaps in the data and in several cases specific locational or case data were extrapolated to larger areas. Experimental data were applied to a more general situation for some alternatives.

A number of assumptions were also used in estimating the benefits foregone and the public infrastructure costs. Some benefits gained or lost could not be quantified and therefore were not measured in this study. Such benefits lost would include waterfowl benefits (except for drainage where they were measured), non-consumptive uses of wildlife and

recreational benefits. Other losses would be the possible impacts of soil erosion and water quality and other environmental impacts. Benefits gained would include soil conservation in fallow reduction and soil amelioration alternatives, municipal and recreational benefits from irrigation expansion and community benefits from Green Area conversion. A qualitative assessment of some of these impacts is provided in the "ALBS: Analysis of Impacts on Other Resources" report. These should be considered when interpreting the results of the analysis in this report.

The base data were associated with specific project lives for each alternative examined. To make the alternatives more comparable with each other each set of results were converted to an infinite period, assuming sustained benefits and costs and repeated investments where appropriate. This assumption, while providing results on a comparable basis, compounds the implications of constant price/cost relationships and constant technology or physical relationships.

In extrapolating from a farm level or a project level to a large scale (several million acres in some cases), it was also necessary to assume a phasing-in rate for practical purposes. This was not meant to indicate possible implementation plans but simply to avoid the unrealistic assumption of instantaneous change. For reporting purposes the alternatives were divided into those requiring major public expenditure and those which required only direct on-farm development.

The base results were subjected to two separate and distinct types of analysis, namely, (i) Direct Net Benefit Analysis and (ii) Multiplier Analysis. These analysis methods and results are not strictly comparable or additive but present the findings from two different perspectives. The major differences between the two analysis methods are in the treatment of capital investments and the inclusion or exclusion of secondary benefits. In the former method, capital investments were treated as costs and no secondary benefits were included (all direct benefits and costs were measured). In the latter method, the value-added from both output and investment were treated as benefits;

and secondary benefits were also measured (both direct and indirect or secondary value-added were included in the total benefits estimate).

13.1.1 Direct Net Benefit Analysis

In this analysis changes in output, whether agricultural, forestry or wildlife, were treated as benefits gained or foregone. All operating or variable costs, as well as, investment costs were deducted from the gross benefits to determine the net benefits of each sector. The difference between the net benefits gained and the net benefits foregone represented the final direct net benefit.

Thus,

(Final) Direct Net Benefit = Net Benefit Gained - Net Benefit Foregone

Where,

Net Benefit Gained (Foregone) = Gross Margin-Investment Costs

And,

Gross Margin (Direct Value-Added) = Gross Value-Operating Costs

No secondary benefits or costs were examined and the project was analyzed on the basis of efficiency aspects, as shown by the valuation of direct benefits and costs. Standard criteria for measuring efficiency (benefit-cost ratio (B/C) analysis and net present value (NPV) analysis) were used in the on-farm economic and financial analysis. In addition, annual equivalent cash flow values (AECF's) were derived from the NPV's for more accurate comparison between alternatives. These results are presented in the "ALBS: Economic and Financial Analysis: Direct Benefits and Costs" report.

In the economic impact analysis all results were expressed as net present values. Benefit-cost ratios were also derived. Since all projects were converted to an infinite life, derivation of AECF's was not necessary. Any project with a positive (final) direct net present value was considered economically feasible on its own merit. An example of the calculation of direct net benefits is provided below.

Example: Range Conversion

(Final) Direct Net Benefit	=	Net Benefit Gained	-	Net Benefit Foregone
(Million) $268	=	307	-	39

Where,

Net Benefit Gained	=	Gross Margin	-	Investment Cost
(Million) $307	=	392	-	85

Thus, the final direct net benefit was $268 million. This indicated that the project would be economically feasible.

13.1.2 Multiplier Analysis

In this analysis, not only changes in output, but all capital investments were treated as contributing direct "value-added" to the economy. Also, secondary benefits (indirect value-added) gained and foregone were evaluated. These two components together formed the total benefit to society.

Thus,

Total Benefit = Direct Value-Added + Secondary Benefits
= Gross Value X Multiplier

Where,

Direct Value-Added = Gross Value - Operating Costs

And,

Secondary Benefit = Total Benefit - Direct Value-Added

Each investment, although a cost to the sector receiving the benefits or a cost to the public sector, represented revenues to other sectors. Gross margins or value-added, rather than net benefits, were measured for all activities. These represented the value-added to the primary inputs (indirect taxes, wages and salaries, net income and surplus). Value-added estimates were derived for benefits gained (agriculture) and benefits foregone (forestry and wildlife) and for investments. They represented the "direct" part of the total benefits derived through multiplier analysis.

To derive the total benefits of each alternative, multipliers were applied to the gross value of the benefits gained or lost, as well as to the investments. The secondary benefits were derived from the difference between the total benefits and the "direct" value-added benefits.

An example of the calculation of total benefits through multiplier analysis is provided.

Example: Range Improvement

	Direct Value-Added	= Gross Value	- Operating Costs
Agriculture(Million)	$ 81	123	42
Investment	27	40	13
Total Gained	108	163	55
Foregone[1] (EXP)	45	72	27
(WTP)	42	42	--
Total Foregone	87	114	27
Change	21		

	Total Benefits	= Gross Value	X Multiplier
Agriculture(Million)	$109	123	0.890
Investment	35	40	0.873
Total Gained	144		
Foregone[1] (EXP)	60	72	0.839
(WTP)	42	--	---
Total Foregone	102		
Change	42		

1. The willingness to pay (WTP) component of benefits foregone represented an extra-market value and had no secondary benefits. The expenditure component (EXP) was based on gross expenditure on the hunting activity and had secondary benefits.

Secondary Benefit		= Total Benefits	- Direct Value-Added
Benefit Gained (million)	$36	144	108
Benefit Foregone	15	102	87
Change	21	42	21

The analysis for alternatives involving public expenditure was slightly more complicated, with an additional row of calculations for each component of the total benefit analysis. Conversely, those with no benefits foregone had a more simplified sequence of analysis.

13.2 SUMMARY OF RESULTS

Results for the direct benefit analysis and the multiplier analysis are presented separately. Key results of each analysis are then shown in the final section. These are also compared with the benefits to farmers as derived through financial anlysis.

13.2.1 Direct Net Benefit

Results of direct net benefits for all alternatives are presented in Table 13.1. The alternatives were grouped as major infrastructure alternatives and direct development alternatives. All the direct development alternatives (except prairie range improvement), were found to be justified on the basis of direct net benefits alone. Two major infrastructure alternatives (Green Area conversion and irrigation expansion) requiring public expenditure, did not meet economic feasibility requirements on the basis of direct net benefits alone. Drainage did meet this criterion in two of the five river basins examined. Woodland conversion was shown to have the highest net present value of $1,788 million and drainage the lowest positive value of $23 million. Prairie range improvement had a negative value.

The second highest value was for the deep plowing alternative, at $422 million. Other alternatives had net present values of between $44 million and $268 million. It must be noted that these values are for

TABLE 13.1

PRESENT VALUE OF DIRECT BENEFITS AND COSTS[1]

Alternative	Acreage	Gross Revenue	Operating Costs	Gross[2] Margin	On-Farm Invest	Public Invest	Net[3] Gained	Net[4] Foregone	Final[5] Net	Final Net
	('000 ac)	(million $)								($/acre)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Major Infrastructure Alternatives										
Green Area Conversion	9,200	3,273	1,515	1,758	989	531	238	1,054	-816	-89
Irrigation Expansion	1,139	1,027	388	639	136	1,647	-1,144	6	-1,150	-1,009
Drainage	2,119	888	149	739	328	374	37	14	23	11
Direct Development Alternatives										
Deep Plowing	2,220	568	0	568	146	0	422	0	422	190
Liming Acid Soils	2,510	219	0	219	95	0	124	0	124	49
Fallow Reduction	930	208	160	48	0	0	48	0	48	51
Range Improvement	1,040	123	42	81	40	0	41	42	-1	-1
Range Conversion	3,530	1,892	1,500	392	85	0	307	39	268	76
Woodland Conversion	7,070	4,915	2,509	2,406	553	0	1,853	65	1,788	253
Saline Reclamation - Dryland	1,310	194	123	71	27	0	44	0	44	34
- Irrigated	250	513	366	147	47	0	100	0	100	400

1. Based on infinite stream of benefits and costs.
2. Value-added or return to land, labor, management and investment. (column 2 - column 3).
3. Net benefits gained after deducting operating and investment costs (column 4 - column 5 - column 6).
4. Calculated in similar manner to net benefits gained. Provided by Forestry and Fish and Wildlife Divisions.
5. Difference between net benefits gained and net benefits foregone (column 7 - column 8).

the total acreages identified for each of the alternatives. When converted to a per acre basis the results are somewhat different. Drainage of irrigated saline soils became the most attractive with an NPV of $400 per acre, next was woodland conversion at $253 per acre, then deep plowing at $190 per acre. Green Area conversion and irrigation expansion were the least attractive at -$89 and -$1,009 per acre respectively. Other alternatives ranged from -$1 to $76 per acre. Drainage was the only major infrastructure alternative having a positive direct net benefit of $11 per acre.

For Green Area conversion, the net on-farm benefits gained ($769 million) were large enough to off-set all the public investment costs related to development ($531 million) but not the measured benefits foregone to forestry and wildlife ($1,054 million). A final net loss of $816 million was derived. This result should be considered together with the farm financial analysis which showed negative returns and a B/C ratio of less than 1.0, with zero equity. However, with equity of over 30 per cent the farm financial results were positive. The implications are that although Green Area conversion may be economically feasible on its own, it does not compensate for the forestry benefits lost. Also, it is only financially feasible to the farmer in the very long run, with medium levels of equity and/or some other source of income to overcome cash flow problems during development years. For every dollar of on-farm investment, there was $3.30 in gross revenue produced, whereas, for every dollar of public investment there was $6.16 of gross revenue.

The irrigation expansion alternative presented favourable results to the farmer with high positive financial returns and B/C ratios greater than 1.0. However, the net on-farm benefits gained of $503 million were not large enough to off-set the public investment cost of $1,647 million. The financial returns to the farmer were positive, partly because of higher returns per acre but mainly because of the relatively lower on-farm investment costs per unit gain in revenue (when compared with Green Area conversion). For every dollar of on-farm investment there was $7.55 in gross revenue produced. However, for every dollar of public investment there was only $0.62 of gross revenue.

The results for drainage showed that at the farm level drainage would be financially feasible. On the large scale, the net on-farm benefits were also positive at $411 million and were large enough to cover public expenditure costs of $374 million and benefits foregone of $14 million. Three river basins showed negative returns but overall for the province there was a net gain to society of $23 million. Gross revenue per dollar of on-farm investment was similar to Green Area conversion at $2.71, however, gross revenue per dollar of public investment was lower at $2.37.

13.2.2 Multiplier Analysis

As explained previously, this analysis examined both direct and indirect value-added and thus provided an estimate of expected growth in the economy. A summary of the "direct" value-added and secondary benefits or "indirect" value-added is provided in Table 13.2. All alternatives except Green Area conversion showed positive total benefits. Irrigation expansion, drainage and woodland conversion had values of $1.9 billion, $1.4 billion and $3.4 billion respectively. For the other alternatives, total benefits ranged from $42 million to $695 million. For alternatives with large investments and large total benefits, the secondary benefits represented approximately 20 per cent to 30 per cent of the total benefits. For the other alternatives the secondary benefits ranged from 4 per cent to as much as 50 per cent of the total benefits.

On a per acre basis, irrigation expansion had the highest total benefit of $1,698 per acre. Reclamation of irrigated saline lands was next at $900 per acre, followed by drainage at $645 per acre. These results provide a fairly conservative estimate of the secondary benefit component of each of the development alternatives. The direct value-added component of the total benefits measured is the gross value (gross output or gross investment) less the operating or variable costs. It represents the value-added to the primary inputs in the agriculture and investment-related sectors less that in forestry, hunting and trapping. (In each sector this value is larger than the net benefit used in the previous analysis, which was derived by deducting the investment or capital cost from the value-added component).

TABLE 13.2

SUMMARY OF VALUE-ADDED BENEFITS

Alternative	Agriculture	On-Farm Invest.	Public	Total Benefits Gained[1]	Benefits Foregone	Totals[2] (Net of Foregone)	Totals[3] (Net of Foregone)
	Present Value (millions)						($/ac)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Major Infrastructure Alternatives							
Green Area Conversion[4]							
Value Added	1,758	560	212	2,530	-2,756	-226	-25
Secondary Benefits	610	186	96	892	-2,606	-1,714	-186
Total	2,368	746	308	3,422	-5,363	-1,941	-211
Irrigation Expansion							
Value Added	639	92	658	1,389	- 12	1,377	1,209
Secondary Benefits	234	26	299	559	- 2	557	489
Total	872	118	957	1,948	- 14	1,934	1,698
Drainage							
Value Added	739	131	149	1,020	26	993	469
Secondary Benefits	250	60	68	377	5	373	176
Total	989	191	217	1,397	31	1,366	645
Direct Development Alternatives							
Deep Plowing							
Value Added	568	101	0	669	0	669	301
Secondary Benefits	0	26	0	26	0	26	12
Total	568	127	0	695	0	695	313
Liming Acid Soils							
Value Added	219	52	0	271	0	271	108
Secondary Benefits	0	23	0	23	0	23	9
Total	219	75	0	294	0	294	117
Fallow Reduction							
Value Added	48	0	0	48	0	48	52
Secondary Benefits	16	0	0	16	0	16	17
Total	64	0	0	64	0	64	69
Rangeland Improvement							
Value Added	81	27	0	108	- 87	21	20
Secondary Benefits	28	8	0	36	- 15	21	20
Total	109	35	0	144	-102	42	40
Rangeland Conversion							
Value Added	392	58	0	450	- 78	372	105
Secondary Benefits	136	16	0	152	- 13	139	39
Total	528	74	0	602	- 91	511	144
Woodland Conversion							
Value Added	2,406	221	0	2,627	-125	2,502	354
Secondary Benefits	836	101	0	937	- 22	915	129
Total	3,242	322	0	3,564	-147	3,417	483
Saline Rec. Dryland							
Value Added	71	15	0	86	0	86	66
Secondary Benefits	25	7	0	32	0	32	24
Total	96	22	0	118	0	118	90
Saline Rec. Irrigated							
Value Added	147	19	0	166	0	166	664
Secondary Benefits	51	8	0	59	0	59	236
Total	198	27	0	225	0	225	900

1. Total benefit gained (column 1 + column 2 + column 3).
2. Total benefits gained less benefits foregone (column 4 - column 5).
3. Column 6/acreage.
4. Benefits foregone are net of timber salvage value.

The secondary benefits on the other hand, represent the value-added benefits to primary inputs of other sectors of the economy, produced through linkages with other industries including petroleum, chemical processing, machinery, etc. These secondary benefits are a reflection of a number of factors including:

1. gross value and gross margin of agricultural output;
2. gross value and gross margin of investment costs (on-farm and public);
3. gross value and gross margin of benefits foregone; and
4. linkages of agriculture, forestry and wildlife sectors and sectors involved in investments to other sectors of the economy (i.e. value of the multipliers).

Changes to any of these factors would affect the value of the secondary benefits and thus of the total benefits. Naturally, the greater the gross value or gross margin (i.e. the higher the increase in output, yields or prices or the lower the production costs) the greater the secondary benefits. The converse is also true. Also, the higher the multiplier, or the greater the spin-off activities, the higher the secondary benefits.

For the purpose of comparison the direct net benefits and the total value-added results are summarized in Table 13.3. Total investment costs are also provided. Finally, it needs repeating that certain non-quantifiable benefits and costs have not been evaluated in this study. For a description of some of these factors the reader is referred to the report "The ALBS Analysis of Impacts on Other Resources".

13.2.3 Farmer Benefits vs. Society's Benefits

This report concentrated on the long term economic impacts of the various agricultural development alternatives on society. It examined the direct net benefits and the value-added benefits through economic (benefit-cost) analysis and multiplier analysis respectively. It is important to reflect on the direct benefits to the farmer and examine

TABLE 13.3

SUMMARY OF NET BENEFITS AND VALUE-ADDED TO SOCIETY

Alternative	Acreage[1] ('000 ac)	Net Direct Benefit[2]	Direct[3] Value-Added	Total[4] Value-Added	Total[5] Investment
		Present Value (million $)[6]			
	(1)	(2)	(3)	(4)	(5)
Major Infrastructure Alternatives					
Green Area Conversion[7]	9,200	-816	1,758	-1,941	1,520
Irrigation Expansion	1,139	-1,150	639	1,934	1,783
Drainage	2,119	23	739	1,366	702
Direct Development Alternatives					
Deep Plowing	2,220	422	568	695	146
Liming Acid Soils	2,510	124	219	294	95
Fallow Reduction[8]	930	48	48	64	0
Range Improvement	1,040	- 1	81	42	40
Range Conversion	3,530	268	392	511	85
Woodland Conversion	7,070	1,788	2,406	3,417	553
Saline Reclamation - Dryland	1,310	44	71	118	27
- Irrigated[9]	250	100	147	225	47

1. Acreage excludes summerfallow reduction on Brown soils and woodland range improvement on all soils and saline reclamation on Black & Gray. (column 1)
2. Economic NPV (returns to land, labor, management and existing investment net of all variable and investment costs and net benefits foregone). (column 2)
3. Value-added in agriculture (gross value less variable costs). (column 3)
4. Direct and secondary value-added in agriculture and public and private investment, less value-added in forestry and wildlife. (column 4)
5. On-farm plus public investment (Green Area Conversion) $531 million, (Irrigation Expansion) $1,647 million and (Drainage) $374 million. (column 5)
6. All present values based on infinite stream of benefits and costs.
7. Analysis does not include benefits associated with municipal and industrial water supply and recreational benefits.
8. No investment costs, therefore the ratio of value-added to investment approaches an infinite value.
9. No off-farm infrastructure cost measured. Where this is required ratios may be affected.

whether the development alternatives were shown to be financially attractive to the farmer within the farmer's planning horizon.

A summary of farmer financial benefits and society's value-added benefits are provided in Table 13.4. The average annual cash flow to the producer is the AECF reported in the "ALBS Economic and Financial Analysis: Direct Benefits and Cost" report. These values were based on specific time frames that would be reasonable for a single investment and they were calculated on the basis of all costs and returns to the farmer (including transfer payments). They did not include costs and returns to society (public expenditure or benefits foregone).

For each investment zero equity was assumed and the costs therefore included financing costs. The results shown indicate that for all alternatives, except Green Area conversion, the investment cost would be covered and the farmer would have a positive benefit or cash flow. For Green Area conversion the cash flow was negative, indicating that the farming operation would have to be subsidized through equity or off-farm income or through additional transfer payments from society. The on-farm economic analysis produced positive results, indicating that investment would be feasible from society's point of view (with transfer payments excluded and with no off-farm costs or benefits foregone measured).

The analysis in this report was based on a longer time horizon with costs and benefits generally assumed to infinity. The results for the direct net benefit to society therefore indicate what benefits would accrue to society over the very long term and not within the limit of the farmer's planning horizon. Also, this analysis was based on economic not financial costs and returns and therefore did not include transfer payments. However, costs and returns to society that would not accrue to the individual farmer were included. These were public infrastructure costs and net forestry and wildlife benefits foregone.

For all alternatives, except Green Area conversion, irrigation expansion and prairie range improvement the net direct benefits were positive, ranging from an NPV per acre of $11 to $400. These are equivalent

TABLE 13.4

SUMMARY OF FARMER BENEFITS AND BENEFITS TO SOCIETY ON A PER ACRE BASIS

Alternative	Average[1] Annual Cash Flow	Net[2] Direct Benefit	Direct[3] Value-Added	Total[4] Value-Added	Total[5] Investment	Ratio of[6]: Direct Value-Added To Total Investment (Col 3/5)	Ratio of[6]: Total Value-Added to Total Investment (Col 4/5)
		---------- Present Value ($/acre) ----------					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Major Infrastructure Alternatives							
Green Area Conversion	-18	-89	191	-211	165	1.16	-1.28
Irrigation Expansion	23 to 130	-1,009	561	1,698	1,565	0.36	1.08
Drainage	17 to 52	11	349	645	331	1.05	1.95
Direct Development Alternatives							
Deep Plowing	17 to 46	190	256	313	66	3.89	4.76
Liming Acid Soils	10 to 11	49	87	117	38	2.31	3.09
Fallow Reduction[7] (excluding Brown Soil Zone)	4 to 12	52	52	69	0	*	*
Prairie Range Improvement	1 to 21	- 1	78	40	38	2.03	1.05
Range Conversion	28 to 41	76	111	144	24	6.11	6.01
Woodland Conversion	26 to 57	253	340	483	75	4.35	6.17
Saline Reclamation							
Dryland	19	34	54	90	21	2.63	4.37
- Irrigated	52	400	588	900	188	3.13	4.79

1. Column 1: Based on financial NPV (return to land, labor, management and existing investment).
2. Column 2: Gross agricultural output less all costs (variable and investment) and benefits foregone.
3. Column 3: Value added in agriculture. (gross value less variable costs).
4. Column 4: Direct and secondary value-added in agriculture and public and private investment, less direct and secondary value-added in forestry and widlife.
5. Column 5: On-farm and public investment.
6. Columns 6 & 7: Indicators of direct and total value-added per dollar of total investment, respectively (these are not benefit/cost ratios as calculated in the Direct Benefits and Costs Analysis).
7. No investment costs, therefore the ratio of value-added to investment approaches an infinite value.

to economic AECF's or annual cash flows of between $2 to $20 per acre. Thus on a per acre basis, although the values were positive (indicating economic feasibility) the net direct benefits of each development alternative were relatively small. These values are measures of economic efficiency and give an indication of the net return to labor, management and existing capital, after all variable costs and new investment costs (private and public) as well as opportunity costs (benefits foregone) are covered. They give an indication of the change in productivity resulting from the investment and a measure of the net return to the agriculture sector.

The results of the multiplier analysis, by contrast, do not measure efficiency or productivity but give an estimate of the impact on Gross Domestic Product (GDP) and thus on growth in the economy. The direct value-added (Table 13.4; column 3) represents the return to primary inputs (including on-farm investment) in the agriculture sector. It thus represents the growth in agriculture GDP. The ratio of this value to the total investment (private plus public) indicates the dollar increase in agriculture GDP for each dollar of investment (Table 13.4; column 6).

For Green Area conversion, irrigation expansion and drainage, these ratios were small reflecting high private and/or public infrastructure costs. The direct development alternatives had ratios of between 2.0 and 6.1. Most of these had relatively low investment costs. For summerfallow reduction, with no investment costs, the ratio would approach infinity.

The total value-added or total benefit (Table 13.4; column 4) is an estimate of the increase in GDP (or return to primary inputs) for all sectors of the economy. It reflects the impact of the investment in agricultural development, as well as the resulting increase in agricultural output on the rest of the economy and the loss produced by benefits foregone in other sectors. The increase in GDP for each dollar of investment is indicated by the ratio of total value-added to total investment (Table 13.4; column 7). For the major infrastructure alternatives, these ratios ranged from a negative value (for Green Area conversion), to a ratio of 1.95 (for drainage). For direct

development alternatives the range was 1.1 to 6.2. These ratio values are dependent on a number of factors and should be considered with other measures provided in this report and in other reports in the ALBS series.

In summary, this report presented the analysis of various agricultural expansion and intensification alternatives from the viewpoint of society. Each alternative was examined from both an efficiency perspective and a growth perspective. A graphic representation of these results is provided in Figure 1. In terms of efficiency, irrigated slaine reclamation, woodland conversion and deep plowing solonetzic soils had the highest net returns per acre.

In terms of growth within the agriculture sector, irrigated saline reclamation, irrigation expansion and drainage had the highest values per acre, followed by woodland conversion and deep plowing solonetzic soils. From the point of view of growth within the provincial economy irrigation, irrigated saline reclamation and drainage had the highest per acre values. Woodland conversion and deep plowing also had relatively high values.

Finally, with respect to growth produced per dollar of investment cost, fallow reduction, range conversion and woodland conversion performed best. (For fallow reduction the ratio would approach an infinite value since there were no investment costs). High public investment options such as Green Area conversion, irrigation expansion and drainage had the lowest returns per dollar of investment. Prairie range improvement which had a high benefit foregone also had a low total benefit per dollar investment.

PROVINCIAL SUMMARY
TOTAL BENEFITS AND COSTS

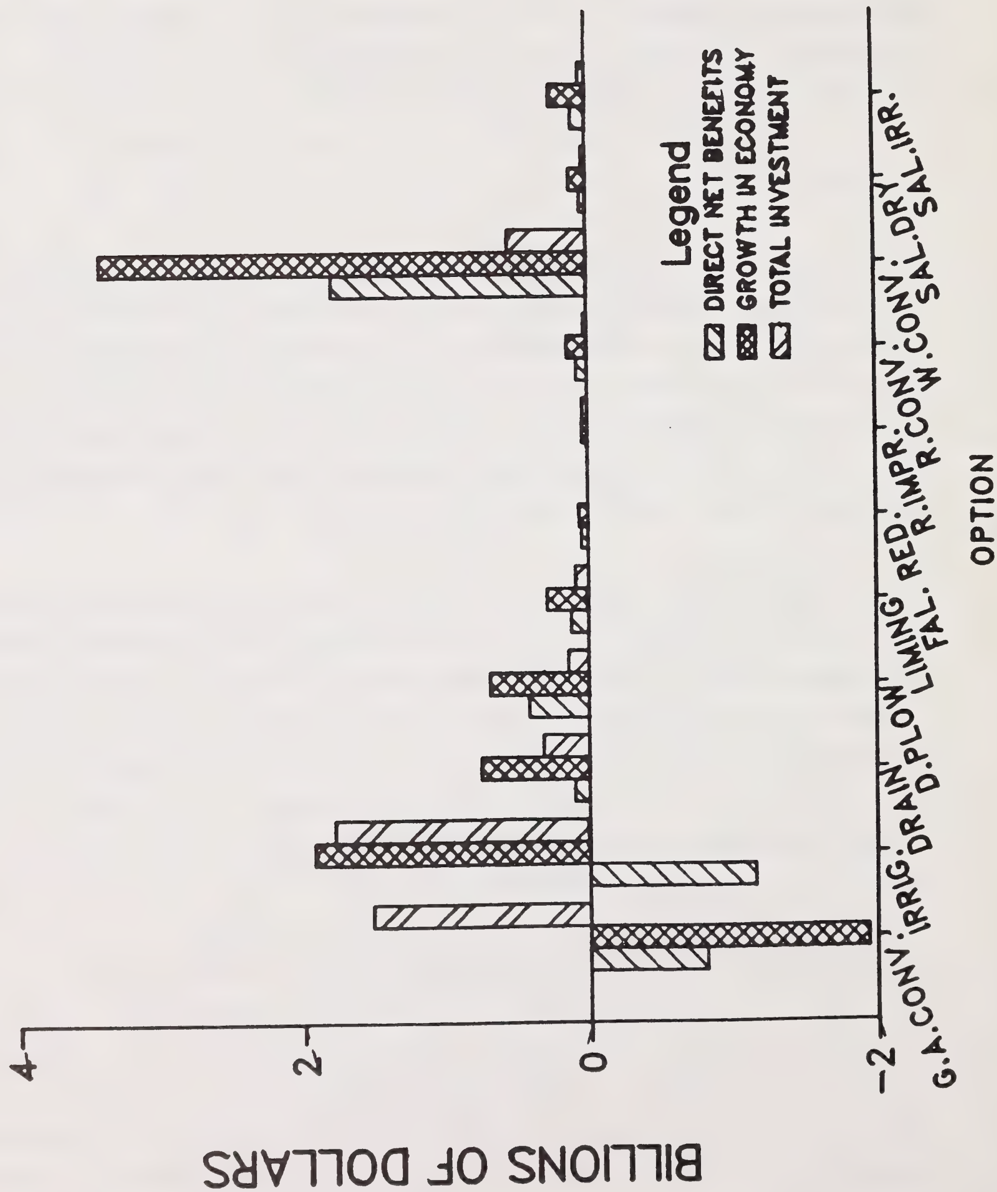

FIGURE 1